SEPTEMBER, 1918

Bulletin of the American Institute of Mining Engineers

PUBLISHED MONTHLY

SPECIAL FEATURES

TECHNICAL PAPERS, See page i.

Bulletin of the American Institute of Mining Engineers

No. 141 SEPTEMBER 1918

CONTENTS

CURRENT MATTERS

TECHNICAL PAPERS

ADVERTISING

Dr. James Douglas.

BULLETIN OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

PUBLISHED MONTHLY

No. 141 SEPTEMBER 1918

Published Monthly by the American Institute of Mining Engineers at 212–218 York St., York, Pa., H. A. Wisotzkey, Publication Manager. Editorial Office, 29 West 39th St., New York, N. Y., BRADLEY STOUGHTON, Editor. Cable address, "Aime," Western Union Telegraph Code. Subscription (including postage), $10 per annum; to members of the Institute, public libraries, educational institutions and technical societies, $5 per annum. Single copies (including postage), $1 each; to members of the Institute, public libraries, etc., 50 cents each.

Entered as Second Class matter January 28, 1914, at the Post Office at York, Pennsylvania, under the Act of March 3, 1879.

COLORADO MEETING

This Bulletin will be received by members at about the time the Colorado Meeting is in session. A general account of the meeting will be printed in the October Bulletin, but it will not be practicable to publish the discussion of the papers at the Colorado Meeting until the November Bulletin.

MILWAUKEE MEETING, OCTOBER 8 to 11, 1918

A special meeting of the Institute, at which the Institute of Metals Division will join with those members who are most interested in iron and steel, and in coal and coke, will be held in Milwaukee, Wis., October 8 to 11, 1918. The technical program is as follows:

INSTITUTE OF METALS DIVISION

Tuesday morning, October 8:

The Metallography of Tungsten, by Zay Jeffries. (*Bulletin* No. 138, p. 1037.)
The Constitution of the Tin Bronzes, by S. L. Hoyt.
Paper, title not given, by C. H. Mathewson.
Notes on Babbitt and Babbitted Bearings, by Jesse L. Jones. (*Bulletin* No. 140, p. 1397.)
Oxygen and Sulphur in the Melting of Copper Cathodes, by S. Skowronski. (*Bulletin* No. 135, p. 645.)
The Relation of Sulphur to the Overpoling of Copper, by S. Skowronski. (*Bulletin* No. 135, p. 651); with discussion by Philip L. Gill. (*Bulletin* No. 140, p. 1156.)

Wednesday morning, October 9:

Symposium on the Conservation of Tin. Those taking part will be the following:
Dr. G. W. Thompson, of National Lead Co.
Mr. G. H. Clamer, of the Ajax Metal Co.
Mr. C. M. Waring, Pennsylvania Railroad Co.
Mr. M. L. Lissberger, of Mark Lissberger & Son, Inc.
Mr. D. M. Buck, American Sheet & Tin Plate Co.
Mr. W. M. Corse, Titanium Bronze Co.
Messrs. Burgess and Woodward, U. S. Bureau of Standards.
Mr. M. L. Dizer, of War Industries Board.
A representative of the Niles-Bement-Pond Co.
A representative of the Bureau of Steam Engineering, U. S. Navy Dept.

Wednesday afternoon, October 9:

The Volatility of the Constituents of Brass, by John Johnston. (*Journal*, Am. Inst. Metals, March, 1918, p. 15.)
Notes on the Metallography of Aluminum, by P. D. Merica and J. R. Freeman, Jr.
The Effect of Impurities on the Hardness of Cast Zinc or Spelter, by G. C. Stone. (*Journal*, Am. Inst. Metals, March, 1918, p. 11.)
Dental Alloys, by Dr. Arthur W. Gray.
Electrolytic Zinc, by C. A. Hansen. (*Bulletin* No. 135, p. 615.)
The Condensation of Zinc from its Vapor, by C. H. Fulton. (*Bulletin* No. 140, p. 1375.)

Thursday morning, October 10:

Notes on Non-metallic Inclusions in Bronzes and Brasses, by G. F. Comstock. (*Journal*, Am. Inst. Metals, March, 1918, p. 5.)
Nichrome Castings, by Mr. Arlington Benzol, of Driver-Harris Wire Co.
Fusible Plug Manufacture, by Messrs. G. K. Burgess and L. J. Gurevich.
Paper, title not stated, by P. D. McKinney.
Application of the Spectroscope to the Chemical Determination of Lead in Copper, by Messrs. Hill and Lucke.
Radium, by Richard B. Moore. (*Bulletin* No. 140, p. 1165.)

IRON AND STEEL SECTION

Session on Iron and Steel. Tuesday morning, October 8

The Limonite Deposits of Mayaguez Mesa, Porto Rico, by C. R. Fettke and Bela Hubbard. (*Bulletin* No. 135, p. 661.)
The Manufacture of Ferro-alloys in the Electric Furnace, by R. M. Keeney. (*Bulletin* No. 140, p. 1321.)
The Manufacture of Silica Brick, by H. LeChatelier and B. Bogitch. (*Bulletin* No. 141, Sept., 1918.)
Notes on Certain Iron-ore Resources of the World, N. Y. Section Meeting of May 23, 1918. (*Bulletin* No. 141, Sept. 1918.)
Recent Geologic Development on the Mesabi Iron Range, Minn. Discussion by Anson A. Betts and J. F. Wolff. (*Bulletin* No. 141, Sept., 1918.)
Moving Pictures on the Triplex Steel Process.

Session on Coal and Coke. Wednesday morning, October 9

The Byproduct Coke Oven and its Products, by W. H. Blauvelt. (*Bulletin* No. 135, p. 597.)
The Use of Coal in Pulverized Form, by H. R. Collins. (*Bulletin* No. 136, p. 955.)
Carbocoal, by C. T. Malcolmson. (*Bulletin* No. 137, p. 971.)
Low-temperature Distillation of Illinois and Indiana Coals, by G. W. Traer. (*Bulletin* No. 141, Sept., 1918.)
Price Fixing of Bituminous Coal by the U. S. Fuel Administration, by R. V. Norris and others. (*Bulletin* No. 141, Sept., 1918.)

Session on Miscellaneous Subjects. Wednesday afternoon, October 9

The Work of the National Research Council, by H. M. Howe.
Moving pictures on Concrete Ships.
Moving pictures on Cripples in the Manufacturing Industries.

NEW YORK MEETING, FEBRUARY 17-20, 1919

In preparation for the 118th meeting, New York, Feb. 17 to 20, 1919, the following committees have been appointed:

Committee on Arrangements

ALLEN H. ROGERS, *Chairman.*
J. E. JOHNSON, JR.
H. C. PARMELEE.
W. S. DICKSON, *Secretary.*
F. T. RUBIDGE.
FOREST RUTHERFORD.
P. G. SPILSBURY.

Committee on Annual Dinner
F. T. RUBIDGE
E. B. STURGIS.

Committee on Luncheon
FOREST RUTHERFORD, *Chairman.*
E. MALTBY SHIPP.

Committee on Patriotic Meeting
H. C. PARMELEE, *Chairman*

LOCAL SECTION NEWS

COLUMBIA SECTION

S. S. FOWLER, *Chairman,* J. C. HAAS, *Vice-chairman,*
LYNDON K. ARMSTRONG, *Secretary-Treasurer,* 720 Peyton Bldg., Spokane, Wash.
W. H. LINNEY. J. F. MCCARTHY.

On July 15, 16, and 17, 1918, through the good offices of Secretary Stoughton, and the courtesy of War Department officials, Columbia Section was able to secure a series of moving pictures which were presented under the auspices of the Spokane Engineering and Technical Association. The title was "The Way Out," representing the activities of individuals who had lost an arm, a leg, or both, yet whose apparent misfortunes were made the stepping stones to advancement in various human activities. The exhibitions were given at Natatorium Park in the evening, each of the three performances being attended by 1000 persons. Later the films were shipped to Kellogg, Idaho, where they were shown in the principal playhouse one evening to a full house.

On July 31, 1918, the Columbia Section participated in the luncheon and other entertainment in honor of Alfred D. Flinn, Secretary of the Engineering Council, who made a trip through the country to meet different classes of engineers, members of the National Societies, for whom he had a message. The entertainment was under the auspices of the Spokane Engineering and Technical Association, Mr. Peter Mogensen presiding. The luncheon was held in the Elizabethan Room, Davenport Hotel, at noon, 35 engineers being present, of whom about one-third were our members.

Mr. Flinn gave a very comprehensive description of the work of the Engineering Council and allied interests of the Engineering Societies, laying particular stress on the necessary and desirable working alliance between the central bodies and the individual members and local sections, and expressing gratification with the responsive attitude of the engineers in every part of the country which he had visited. After some important messages, which were discussed, some of the local engineers added some pertinent suggestions: Among these were Messrs. J. C. Ralston; C. A. Lund; A. D. Butler; J. B. Fisken; L. K. Armstrong, and

others. A conference after the luncheon was followed by a visit to points of interest within the city limits and beyond, through the courtesy of Mrs. J. C. Haas, wife of the Vice-chairman of Columbia Section. A dinner was served at 6.30 at which some 15 were present, and Mr. Flinn left for Butte by a late train. His visit will have had some lasting beneficial results.

L. K. ARMSTRONG, *Secretary.*

BOSTON SECTION

We have received a letter from Mr. August H. Eustis, explaining his remarks at the forty-eighth meeting of the Boston Section, May 6, 1918 (*Bulletin* No. 139, p. xii) regarding methods of disposing of sulphuric acid fumes at the West Norfolk smelter of the Virginia Smelting Company.

As reported in the minutes of that meeting, it was stated: "The original intention was to run these solutions into the harbor, but, owing to a suit instituted by oyster growers about this time, it was thought best to remove most of the sulphur dioxide before doing so." Fearing that this report of his speech may lead to misapprehension, Mr. Eustis now writes: "When the plant was first built we were all very much afraid about the disposal of these liquors, and feared that they might make themselves a nuisance, where they ran into the harbor. Subsequent experience has proved that this is not at all the case. As a matter of fact, it is almost impossible to detect the presence of the liquors in the harbor, even close to the mouth of the sewer, where they discharge, regardless of whether the sulphur dioxide extracting plant is in operation, or not."

DIED IN SERVICE

Bailey, Lewis Newton, Master Engineer, Senior Grade, 4th Regiment, U. S. Engineers, Headquarters Company, died of pneumonia at Camp Merritt, N. J., on April 30, 1918.

Baird, Louis, Lieut., Royal Field Artillery, British Army, died on the battlefield in 1915.

Cobeldick, William Morley, Royal Engineers, died from gas poisoning on October 7, 1915.

Dougall, Ralph, killed in action.

Evans, Alfred Winter, Lieut.-Col., New Zealand Rifle Brigade, D. S. O., D. C. M., killed in action on October 12, 1917.

Gorman, Thomas C., Lieut., Canadian Engineers, killed in France, Mar. 18, 1918.

Hague, William, 1st Lieut., Engineer Officers' Reserve Corps, died in active service.

Hall, William T., Capt., Royal Flying Corps, killed in action.

Heine, Bernhardt E., Lieut., Aviation Service, killed at Fort Sill, Okla., Aug. 10, 1918.

Irving, John Duer, Capt., 11th Engineers, A. E. F., died while on active service in France on July 26, 1918.

Perry, Edward H., 1st Lieut., Co. D, 6th Regiment Engineers, U. S. Expeditionary Forces, France, killed in action on March 30, 1918.

Pretyman, Frank Remington, 2d Lieut., Royal Engineers, killed in action on June 17, 1916.

Reece, Fred. B., Capt., Royal Engineers, B. E. F., 232d Army Troops Co., killed in action.

Ringlund, Soren, Medical Department, Fort Logan, Colo., died suddenly in camp on July 24, 1918.

Roper, George, Jr., Lieut., Royal Flying Corps, killed in aero accident in England on May 25, 1918.

NEWS FROM MEMBERS AT THE FRONT

John M. Cairns, in an interesting letter dated June 19, 1918, tells us of his experiences in Italy. He says, "It may interest you to know I came out to Italy after being on the Afghan frontier of Indian Baluchistan, in August last year, and for some time was posted at Turin as Railway Transport officer. At that time Turin was in the toils of the riots which were the forerunners and preliminaries which led up to the great Italian retreat (Capretto). Since then I have been all over Italy from (deleted by the censor) in Transportation intelligence, and now have just been transferred to the Directorate of Requisitions and Hirings, which now permits great opportunities of going nearly all over Italy (deleted by the censor).

My address is L. of C. Branch, D. R. & H., A. P. O. L/1, I. E. F.

Thomas S. Chalmers, formerly Captain, Ordnance, in non-ferrous metals department, Procurement Division, Washington, has been appointed Major, Ordnance, N. A.; he left for foreign parts May 23, 1918, and arrived somewhere abroad.

G. A. Denny writes us that his brother H. S. Denny has been for 3 years in charge of Government explosives factories, and as a sign of approval he has recently been given the award of "Commander of the Order of the British Empire."

ADDITIONAL LIST OF MEMBERS OF THE INSTITUTE IN MILITARY SERVICE

(The following list contains the names of those members of the Institute of whose connection with military service we have only recently become acquainted; it also includes the names of a few who have recently been promoted or transferred. A complete list was published in the Year Book, issued as a supplement of the *Bulletin* for March, 1918.)

ANDREWS, CLARENCE W., 2d Lieutenant, 12th Batt. Infantry Replacement Regiment.

ANDREWS, JOSEPH C., Ordnance Dept., U. S. A.

ARLUCK, A. A., Headquarters, 1st Corps of Artillery, A. P. O. No. 759, A. E. F.

AYER, FRANK A., 1st Lieutenant, 353d Aero Squadron, A. E. F.

BALL, EDWIN M., 51st Infantry, Headquarters Co.

BALL, TOM LEE, Naval Aviation.

BOUDWIN, WALKER J., Administrative Labor Co., No. 46 (Spanish) A. P. O. 713, A. E. F.

CAMPBELL, WILLIAM, Lieutenant Commander, U. S. N. R. F., New York Navy Yard.

CATLETT, CHARLES, Chemical Division of the War Industries Board.

CHAPMAN, LEWIS G., Co. F, 604th Engineers.

CLARK, HOWELL SMITH, Co. E, 1st Replacement Regiment, Engineers.

COOPER, CLAUDE H., Captain, Coast Artillery Reserve Corps, 50th Artillery, Camp Eustis, Va.

CURRIE, DAVID, Director General, National Salvage Council, Caxton House, Westminster, S. W. I., London.

DELANO, FREDERIC A., Major, Engineer Reserve Corps, A. E. F.

DICKSON, ROBERT HENRY, 1st Lieutenant, C. A. N. A., Fortress Monroe, Va.

DUNN, T. S., Captain, 538th Engineers, Camp Meade, Md.

EATON, LUCIEN, Captain, Engineer Reserve Corps, Provisional Co. 4, E. R. O. T. C.

EDWIN, JOHN, Company A, 27th Engineers, A. E. F.

ELY, FRED B., 1st Lieutenant, Aviation Section, N. A.

FAIRBAIRN, GEORGE, Captain, 252d Co., Royal Engineers, British E. F., France.

FASSETT, N. C., Section 600, U. S. A. Ambulance Service, A. E. F. with Italian Army.

FORD, HAROLD P.

FRASER-CAMPBELL, EVAN, 2d Lieutenant, 180th Tunnelling Co., R. E., British E. F.

GILBERT, DONALD C., Company L, 1st Replacement Regiment, Engineers.

HOPPER, WALTER E., Bureau of Research, War Trade Board.

HOUSHOLDER, E. ROSS, Company L, 1st Replacement Regiment, Engineers.

IMHOFF, WALLACE G., Lieutenant, Assistant Engineer, Airplane Motor Dept. Rich Field, Waco, Texas.

KULLMAN, JOSEPH J., 1st Lieutenant, Company A, 113th Engineers, A. E. F.

LAMB, HERBERT W., Captain, Engineers N. A., Post Headquarters, Fort Benjamin Harrison, Ind.

LOVEJOY, J. M., Lieutenant, F. A. R. C. Saumur Artillery School, A. P. O. No. 718, A. E. F.

MCADAM, D. J., JR., U. S. Naval Engineering Experimental Station, Annapolis, Md.

MCALLEN, JOHN L., Lieutenant, Company B, 602d Engineers, A. E. F.

MCCONNELL, ROBERT E., Lieutenant, U. S. N. R. F., Room 6312, New Interior Bldg., Navy Dept.

MCNAIR, F. W., Associate Engr. Physicist, Bureau of Standards, Washington, D. C.

MAGNUS, BENJAMIN, Captain, Engineer Reserve Corps.

MILYKO, ALEXANDER, Sergeant, 2d Battery, F. A. C., O. T. S. Camp Taylor.

MOGA, JOHN A., 9th Co., C. A. C., of C. B.

NEGRU, JACQUES S., Pvt. No. 2504000, Canadian Railway Troops, Depot, Draft No. 76, Purfleet, Essex, England.

NELSON, H. C., 27th Engineers, A. E. F.

NELSON, W. I., Balloon Co., 64, Arcadia, Cal.

NEWBY, JERRY B.

OUGH, S. W., Care N. W. J. Gibson, 7 Officers Quarters, Royal Arsenal, Woolwich.

PAGE, WILLIAM KINGMAN, Lieutenant, Ordnance Reserve Corps, Inspector of Ordnance.

POND, WALTER F., Captain, Headquarters 30th Engineers .(Gas & Flame Regiment) A. E. F.

PRICE, HAROLD C., 1st Lieutenant, C. A. R. C., 53d Ammunition Train, C. A. C., A. E. F.

PRICE, VIRGIL T., 10th Co., 164th Depot Brigade, Camp Funston, Kansas.

RANKIN, JAMES.

READ, J. BURNS, Captain, Ordnance Reserve Corps, Inspection Division.

ROSS, CLYDE P., Photographic Branch, Dept. of Military Aeronautics.

ROUSH, G. A., Captain, Ordnance Dept., U. S. Army. Head of Educational Branch, Inspection Division, 6th & B. Sts., N. W., Washington, D. C.

SEAMON, W. H., JR., Company A, 27th Engineers, A. E. F.

SEARING, OLIVER P., Care Construction Quartermaster, Camp Shelby, Hattiesburg, Miss.

SMITH, F. G., Metallurgist, Ordnance Dept., Inspection Division, Non-ferrous Metals Branch.

SMITH, FRANK A., 2d Batt., Ordnance Detachment C.

SMITH, SYDNEY L., Major, E. R. C. 514th Engineers, A. P. O. No. 731, A. E. F.

SOMMERVILLE, WILLIAM B., JR., Lieutenant, C. A. C., Fort Terry, N. Y.

STARKEY, TOM R., Lieutenant, Company C, 1st Lakour Batt., R. E.

STEWART, LLOYD L., U. S. Government Inspector, Care Hercules Powder Co., Berkeley, Cal.

TEETS, JOHN N., U. S. Naval Aviation Detachment, Company 22, Mass. Institute of Technology.

VISEL, C. E., Company M, 1st Engineers Training & Replacement Regiment, Washington Barracks, D. C.

WALTERS, CHARLES W., Ensign, U. S. Naval Air Station, St. Trojan, Cherante Inf're, France.

WILLIAMS, EDWARD I., Candidate, 2d Training Co., C. A. C., Fort Monroe, Va.

WILLIAMS, P. T., 2d Lieutenant, 6th Reserve Batt., R. E.

WEBERT, LOUIS P., Chemist, U. S. Naval Engineering Experiment Station, Annapolis, Md.

WRIGHT, FRED E., Captain, Ordnance Reserve Corps, War Industries Board.

YATES, A., Ministry of Munitions, Yorkshire, England.

U. S. ARMY GAS SERVICE

By executive order of the President, dated June 25, 1918, the investigation of matters relating to gas warfare, which had been initiated by the Director of the U. S. Bureau of Mines early in 1917, and had been continuously maintained and improved since that time, was transferred to the recently created Division of Gas Warfare of the War Department. On the occasion of this transfer, both the President and the Secretary of War took occasion to speak most highly of the efficient service that had been rendered by the Bureau of Mines.

It gives us great pleasure to reproduce here a letter from the President and from the Secretary of War, bearing on this subject and also to append a brief review of the work of the Bureau of Mines, prepared by its Director, Mr. Van H. Manning.

The White House, Washington.

June 26, 1918.

MY DEAR MR. MANNING:

I have had before me for some days the question presented by the Secretary of War involving the transfer of the chemical section established by you at the American University from the Bureau of Mines to the newly organized Division of Gas Warfare in which the War Department is now concentrating all the various facilities for offensive and defensive gas operations. I am satisfied that a more efficient organization can be effected by having these various activities under one direction and control, and my hesitation about acting in the matter has grown only out of a reluctance to take away from the Bureau of Mines a piece of work which thus far it has so effectively performed. The Secretary of War has assured me of his own recognition of the splendid work you have been able to do, and I am taking the liberty of enclosing a letter which I have received from him, in order that you may see how fully the War Department recognizes the value of the services.

I am to-day signing the order directing the transfer. I want, however, to express to you my own appreciation of the fine and helpful piece of work which you have done, and to say that this sort of team work by the bureaus outside of the direct war-making agency is one of the cheering and gratifying evidences of the way our official forces are inspired by the presence of a great national task.

Cordially yours,
WOODROW WILSON.

Dr. Van. H. Manning,
Chief, Bureau of Mines,
Department of the Interior.

War Department, Washington, June 25, 1918.

MY DEAR MR. PRESIDENT:

In connection with the proposed transfer of the chemical section at American University from the Bureau of Mines to the newly constituted and consolidated Gas Service of the War Department, which you are considering, I am specially concerned to have you know how much the War Department appreciates the splendid services which have been rendered to the country and to the Army by the Department of the Interior, and especially by the Bureau of Mines under the direction of Dr. Manning. In the early days of preparation and organization, Dr. Manning's contact with scientific men throughout the country was indispensably valuable. He was able to summon from the universities and the technical laboratories of the country men of the highest quality and to inspire them with enthusiastic zeal in attacking new and difficult problems which had to be solved with the utmost speed. I do not see how the work could have been better done than he did it, and the present suggestion that the section now pass under the direction and control of the War Department grows out of the fact that the whole subject of gas warfare has assumed a fresh pressure and intensity, and the director of it must have the widest control so as to be able to use the resources at his command in the most effective way possible. The proposal does not involve the disruption of the fine group of scientific men Dr. Manning has brought together, but merely their transfer to General Sibert's direction.

Respectfully yours,
NEWTON D. BAKER.

Development of Gas Warfare Work by the Bureau of Mines

The Bureau of Mines, in its work on mining problems, has made a study of poisonous and explosive gases, the use of rescue apparatus and masks of various kinds for entering and exploring noxious atmospheres, methods of treatment of gas cases, and other matters pertaining to these problems. This work has extended over a period of about 10 years. Many publications have been issued by the Bureau on these subjects and many practical results have been obtained.

Early in February, 1917, when war between the United States and the Central Powers seemed inevitable, the Bureau of Mines called the attention of the War Department to the already existing technical organization in the Bureau, for the study of poisonous gases in mines, gas masks, etc., and offered the facilities of the Bureau to the War Department for this work. A meeting was arranged between representatives of the Bureau and the War College. At this conference the War Department enthusiastically accepted the offer of the Bureau of Mines and agreed to support the work in every way possible.

The Director of the Bureau of Mines immediately directed investigations on these war problems, and until July 1, 1917, carried the work along with funds of the Bureau. The first work was done on the development of gas masks. On July 1, 1917, the staff consisted of 50 paid investigators and the work had expanded from gas mask research to the study of poison gases and chemical warfare appliances for offense purposes.

In order to enlist the coöperation of the universities and research institutions in the United States, personal visits were made to practically all of the important ones. The response was most gratifying. Up to the present time some extremely important work has come out of these universities and institutions.

On April 6, 1917, the following committee on gases used in warfare was formed by the National Research Council for the purpose of coöperating with the Bureau of Mines in connection with this work:

VAN H. MANNING, Chairman	Director, U. S. Bureau of Mines.
GEORGE E. HALE (Ex-Officio) National Research Council	Director, Mt. Wilson Solar Observatory.
LT.-COL. R. A. MILLIKAN (Ex-Officio) National Research Council	Science and Research Division, Signal Corps.
CARL L. ALSBERG	Chief, Bureau of Chemistry, U. S. Department of Agriculture.
MAJ. EARL J. ATKISSON	Corps of Engineers, U. S. A.
LT.-COL. MARSTON T. BOGERT	Chemical Service, N. A.
LT.-COL. BRADLEY DEWEY	Gas Defense Service, Surgeon General's Office.
A. H. MARKS	Director, Gas Service, U. S. A.
LIEUT. JOSEPH R. PHELPS	P. A. Surgeon, Bureau of Medicine, and Surgery, U. S. N.
LT. COL. EARL J. W. RAGSDALE	Bureau of Ordnance, U. S. A.
LIEUT. T. W. WILKINSON	Bureau of Ordnance, U. S. N.

This committee has worked in hearty coöperation with the Bureau of Mines.

Until August, 1917, the Bureau of Mines also supervised the construction of gas masks.

On Nov. 7, 1917, Secretary Lane appointed the following Advisory Board to the Director of the Bureau of Mines on war problems,

DR. WM. H. NICHOLS	PROF. H. P. TALBOT
PROF. E. C. FRANKLIN	DR. F. P. VENABLE
DR. C. L. PARSONS	DR. IRA REMSEN
MR. WM. HOSKINS	PROF. T. W. RICHARDS

Since that date the Board acted in an advisory capacity to the Director on the gas work, both as individuals and as a body. The Board first met on Dec. 17, 1917, and visited the laboratories and consulted with the research staff. They were also given a demonstration of the work in progress and full reports were made to the Board by all section chiefs. A second meeting was held May 15 and 16, 1918, when the work was again reviewed.

It was finally decided that the Bureau of Mines would remain as a research organization, making recommendations to the Army and Navy regarding the kinds of masks and nature of gases to be used, together with their method of manufacture, and that the construction of the mask proper should be transferred to the Surgeon-General's Office of the Army. The organization working for the Bureau of Mines was turned over to this department of the Army and formed the nucleus of the present huge organization working on the construction of gas masks and other appliances for gas defense.

On Sept. 15, 1917, many of the experimenters working for the Bureau of Mines on war gas problems moved into the present headquarters of the organization at the American University, on the outskirts of Washington. The University authorities turned over the use of two large buildings at this place, rent free, but with the proviso that some of the alterations and additions, necessary for the proper conduct of the work, would be permanent and become the property of the University after the war was over. The lease of the buildings and grounds of the University extends to a period two years from July 1, 1917, or during the war if it should extend beyond the two-year period.

In December, 1917, a chemical corps was established in the National Army and a part of the unit was sent to France. This unit is composed largely of men trained in the Bureau of Mines' organization. In December, also, a staff of chemical engineers, working for the research organization of the Bureau of Mines, developing processes for manufacturing gases, was transferred to the Bureau of Ordnance of the War Department and formed the nucleus of the present organization building huge plants for the manufacture of poison gases. Another organization, which had its inception under the Bureau of Mines, and has for its head a man who worked for the Bureau and received his training on noxious gas methods, is the proving ground unit of the War Department, established at Gunpowder Neck, for actually trying out gases on an artillery scale after they have been studied by the research organization.

The personnel of the research organization also included a group working on chemical warfare devices. These substances include aeroplane gas bombs, signal lights, smoke screens to screen merchant ships from enemy submarines, gas shells, incendiary shells, gas bombs, trench projectors for firing gas bombs, flaming guns, etc., and important recommendations have gone from the research organization covering such mate-

rials which have been adopted by departments of the Army and Navy interested and put into production.

By reason of the work of the Bureau of Mines in inaugurating the gas warfare program with the hearty support of the Army and Navy Departments, the National Research Council, state, educational, and private institutions, we are undoubtedly months ahead of where we would otherwise have been; our soldiers have gas masks, and will have gases with which to combat the Germans. Further, the developments in gas mask manufacture by the Surgeon General's Office of the Army, in gas manufacture and gas proving ground tests by the Bureau of Ordnance, and in the chemical warfare program of the Navy, including the use of smoke screens, shells, toxic gases, etc., are the results from this experimental work.

The scientific achievements of the Bureau of Mines have been many, but the results cannot be given at this time for reasons that are obvious. It is sufficient to say that due to the energy of the research organization of the Bureau of Mines, the large-scale production of toxic gases is far ahead of the supply of shells.

The Advisory Chemical Board said of the work being done by the Bureau of Mines: "The efficiency, success, fine spirit, and enthusiasm under the leadership of the Bureau of Mines is a matter upon which we wish to congratulate the Bureau, as well as upon the splendid group of unselfish, self-sacrificing men who carried on this arduous and dangerous work."

At that time, before the transfer of the work, the Chemical Board added: "The organization is complex and delicate but well articulated and working with an efficiency and enthusiasm which has impressed us greatly."

Great credit should go to the scientific men of the country who responded so willingly and so generously to the call for assistance in the very early days of the war. They made possible the creation of perhaps a unique and very complete organization which has already accomplished wonderful things in behalf of the War Department. The organization now includes more than 1800 chemists and, of course, among them the leading chemists of the United States. The gas warfare work is one of the few undertakings that has not met with the criticism of delay. The Bureau of Mines, through its knowledge of gases in mines and rescue work had a small nucleus of experts who went right after this work from the very start and at a time when the War Department was almost overwhelmed with other important problems. The Bureau of Mines takes a little credit because its own engineers and chemists were ready and went ahead with important work, using its own funds until such time as the Army and Navy Departments were able to come to its rescue. For this reason, the work is far in advance of what it would have been otherwise.

VAN H. MANNING, *Director.*

AMERICAN SHIPS

The following letter has been received from the Chairman of the United States Shipping Board.

August 1, 1918.

American Institute of Mining Engineers,
New York, N. Y.

GENTLEMEN:

I am going to call upon your organization for some teamwork.

The time has come for Americans everywhere to put themselves solidly behind American ships.

Our railroads must no longer stop at the ocean. We are building an American merchant fleet of twenty-five million tons—three thousand ships. We are backing modern ships with modern port facilities, establishing our bunkering stations all over the globe and will operate with American railroad efficiency. We will carry American cargoes at rates corresponding to our railroad rates—the cheapest in the world. Fast American passenger-and-cargo liners will run regularly to every port in Latin America, the Orient, Africa, Australia.

Are you taking steps to use these ships to increase your own prosperity? Do you realize that American products of factory, farm and mine can be delivered to customers in foreign countries on terms which will build lasting trade?

Do you realize the possibilities for bringing back raw materials to extend your products and trade?

We must all take off our coats and work to bring these American ships home to the people of every American interest and community. The manufacturer must think of customers in Latin America as being as accessible as those in the next state. The farmer must visualize ships carrying his wheat, cotton, breeding animals, dairy products and fruit to new world markets. The American boy must think of ships and foreign countries when he chooses a calling.

Has your organization appointed a live committee on Merchant Marine?

Is the Chairman of this committee a man of international vision?

Are you applying the new world vision to the interests represented in your organization and learning what ships can do toward widening your markets?

These are Your ships. It is your duty to bring them close, regard them as new railroads, spread knowledge about them through investigation, meetings, discussion.

Public neglect ruined our old mercantile marine. Congress was not to blame—it simply reflected the indifference toward ships of the average American. Once more we have a real American merchant fleet under way, backed by far reaching policies for efficient operation. We must dispel indifference and keep our flag on the trade routes of the world. We are going to take trade from no other nation. But we must serve our own customers and help other nations in their ocean transportation problems after the war.

I want to hear personally from your organization. These are precious days of opportunity. The nation is united for teamwork and service. Let us "Wake Up, America!"—which means waking up ourselves. I expect you to write me outlining your views and making any suggestions that you think will be helpful in our work.

With personal good wishes, I am
Yours very sincerely,
EDWARD N. HURLEY, *Chairman.*

SAVINGS vs. SAVAGERY

By Rudyard Kipling

Through the courtesy of the British Museum of Natural History we have received a copy of an address delivered by Rudyard Kipling at Folkestone, Feb. 15, 1918. We take pleasure in reproducing it in full, because its sentiments are just as appropriate here and now as they ever were.

If you will allow me, I will tell you a story. Once upon a time, a hundred years ago, there was a large and highly organised community in India who lived by assassination and robbery. They were educated to it from their infancy; they followed it

as a profession, and it was also their religion. They were called Thugs. Their method was to disguise themselves as pilgrims, or travellers, or merchants, and to join with parties of pilgrims, travellers, and merchants moving about India. They got into the confidence of their victims, found out what they had on them, and in due time—after weeks or months of acquaintance—they killed them by giving them poisoned foods—sweetmeats for choice—or by strangling them from behind as they sat over the fire of an evening, with a knotted towel or a specially prepared piece of rope. They then stripped the corpse of all valuables, threw it down a well or buried it, and went on to the next job.

At last things got so bad that the Government of India had to interfere. Like all Governments, it created a Department—the Department of Thuggee—to deal with the situation. Unlike most Departments, this Department worked well, and after many years of tracking down and hanging up the actual murderers, and imprisoning their spies and confederates, who included all ranks of society, it put an end to the whole business of Thuggee.

The world has progressed since that day. By present standards of crime those Thugs were ineffective amateurs. They did not mutilate or defile the bodies of the dead; they did not torture, or rape, or enslave people; they did not kill children for fun, and they did not burn villages. They merely killed and robbed in an unobtrusive way as a matter of education, duty, and religion, under the patronage of their goddess, Kali the Destroyer. Very good.

German International Thuggee

At the present moment all the Powers of the world that have not been bullied or bribed to keep out of it have been forced to join in one International Department to make an end of German international Thuggee, for the reason that if it is not ended life on this planet becomes insupportable for human beings. Even now there are people in England who find it hard to realise that the Hun has been educated by the State from his birth to look upon assassination and robbery, embellished with every treachery and abomination that the mind of man can labouriously think out, as a perfectly legitimate means to the national ends of his country. He is not shocked by these things. He has been taught that it is his business to perform them, his duty to support them, and his religion to justify them. They are, and for a long time past they have been, as legitimate in his eyes as the ballot in ours. This, remember, was as true of the German in 1914 as it is now.

People who have been brought up to make organised evil in every form their supreme good, because they believe that evil will pay them, are not going to change their belief till it is proved that evil does *not* pay. So far, the Hun believes that evil *has* paid him in the past, and will pay him better in the future. He has had a good start. Like the Thug, the Hun knew exactly what he meant to do before he opened his campaign against mankind. As we have proof now, his poisoned sweetmeats and knotted towels were prepared years beforehand, and his spies had given him the fullest information about all the people he intended to attack. So he is doing what is right in his own eyes. He thought out the hell he wished to create; he built it up seriously and scientifically with his best hands and brains; he breathed into it his own spirit that it might grow with his needs; and at the hour that he judged best he let it loose on a world that till then had believed there were limits beyond which men born of women dared not sin.

When the Veil is Lifted

Nine-tenths of the atrocities Germany has committed have not been made public. I think this a mistake. But one gets hints of them here and there—Folkestone has had more than a hint. For instance, we were told the other day that more than 14,000 English non-combatants—men, women, and children—had been drowned, burned, or blown to pieces since the war began. But we have no conception—and till the veil is lifted after the war we shall have no conception—of the range and system of these atrocities. Least of all shall we realise, as they realise in Belgium and occupied France just across the water, the cold organised miseries which Germany has laid upon the populations that have fallen into her hands, that she might break their bodies and defile their souls. That is part of the German creed. What understanding is possible with a breed that has worked for and brought about these things? And so long as the Germans are left with any excuse for thinking that such things pay, can any peace be made with them in which men can trust? None. For it is the

peculiar essence of German kultur, which is the German religion, that it is Germany's moral duty to break every tie, every restriction, that binds man to fellow-man, if she thinks it will pay. Therefore all mankind is against her. Therefore all mankind must be against her till she learns that no race can make its way or break its way outside the borders of humanity.

"A Hell Without Hope"

The more we have suffered in this war the more clearly do we see this necessity. Our hearts, our reason, every instinct in us that lifts us above the mere brute, shows us that the war must go on. Otherwise earth becomes a hell without hope. The men, the ships, the munitions must go forward to the war, and behind them must come the money, without which nothing can move. Where our hearts are there must our treasure be also.

There has been a great deal of money spent in England lately, several millions a day for the last twelve hundred days. That means that many people have had the chance of earning more money—in some cases very much more money—than they could have earned in peace time. But all the money in the world is no use to a man or his country if he spends it as fast as he gets it. All he has left is his bills and the reputation of being a fool, which he can get much more cheaply in other ways. There's nothing fine or funny in throwing away cash on things you don't want merely because the cash is there. We've all done it in our time and we've all had to pay for it. The man who says he never worries about money is the man who has to worry about it most in the long run, and goodness knows there's enough worry in the world already without our going out of our way to add to it. Just now we all have the opportunity of protecting ourselves against private and public anxieties by investing as much as ever we can in War Loans.

"Money Sits Up All Through the Year"

Money is a curious article. Have you ever thought that invested money is the only thing in the world, outside the Army, the Navy, and the Mercantile Marine, that will work for you while you sleep?. Everything else knocks off, or goes to bed, or takes a holiday at intervals, but our money sits up all through the year, working to fetch in the 5 per cent. interest that the Government gives on every pound it borrows from us. I am not a financier. But I do know that much, and I do know that a man who has an income, however small, from money he has saved, is free of worry and anxiety for himself, his wife, and his children, up to the extent of that income. It gives him self-respect, a more even temper, a reason for looking at the future with calm and confidence. A man who has wasted or muddled all his pay at the end of the week is the servant of the whole world for his next week's pay. The man who has his bit in hand is independent of the world as far as that bit goes, and that knowledge at the back of one's head must make life a different affair to every thinking man or woman.

Savings represent much more than their mere money value. They are proof that the saver is worth something in himself. Any fool can waste, any fool can muddle; but it takes something of a man to save, and the more he saves the more of a man does it make him. Waste and extravagance unsettle a man's mind for every crisis; thrift, which means some form of self-restraint and continence, steadies it. And we need steady minds just now.

Remember, too, that everything we waste in the way of manufactured goods, from a match upward, as well as everything we buy that isn't absolutely necessary to get on with, means diverting some man or woman's time and energy from doing work connected with the war. And war work, which means supplies, food, munitions, ships, is the only thing that is of the least importance now. Everything outside that necessity is danger and waste.

So you see we are all in a splendid position to invest. Not only is there more money going about and fewer things to buy with it, but it is also wrong to spend money on what there is available. The road has been cleared of all obstacles to saving. The interest on what we save helps to make us personally independent; the money we lend to the Government helps to set our land and our world free. Our security for our loan is not only the whole of the British Empire, but also the whole of civilisation, which has pooled its resources in men, money, and material to carry on this war to victory. Nothing else under heaven matters to-day except that the war should go on to that end.

The Personal War Aim

From time to time the representatives of the Allies meet together and lay down what the war aims of the Allies are. From time to time our statesmen repeat them. They all agree we are fighting for freedom and liberty, for the right of small States to exist, and for nations to decide for themselves how they are to be governed. All this we understand and perfectly believe. That is the large view of the situation. What is the personal aspect of the case for you and me? We are fighting for our lives, the lives of every man, woman, and child, here and everywhere else. We are fighting that we may not be herded into actual slavery such as the Germans have established by force of their arms in large parts of Europe. We are fighting against eighteen hours a day forced labour under the lash or at the point of the bayonet, with a dog's death and a dog's burial at the end of it. We are fighting that men, women, and children may not be tortured, burned, and mutilated in the public streets, as has happened in this town, and in hundreds of others. And we will go on fighting till the race that has done these things is in no position to continue or repeat the offence.

If for any reason whatever we fall short of victory—and there is no half-way house between victory and defeat—what happens to us? This. Every relation, every understanding, every decency upon which civilisation has been so anxiously built up will go—will be washed out, because it will have been proved unable to endure. The whole idea of Democracy—which at bottom is what the Hun fights against—will be dismissed from men's minds, because it will have been shown incapable of maintaining itself against the Hun. It will die; and it will die discredited, together with every belief and practice that is based on it. The Hun ideal, the Hun root-notions of life, will take its place throughout the world.

If We Fail——

Under that dispensation man will become once more the natural prey, body and goods, of his better-armed neighbour. Women will be the mere instrument for continuing the breed: the vessel of man's lust and man's cruelty; and labour will become a thing to be knocked on the head if it dares to give trouble, and worked to death if it does not. And from this order of life there will be no appeal, no possibility of any escape.

This is what the Hun means when he says he intends to impose German kultur —which is the German religion—upon the world. This is precisely what the world has banded itself together to resist. It will take every ounce in us; it will try us out to the naked soul. Our trial will not be made less by the earnest advice and suggestions that we should accept some sort of compromise, which means defeat, put forward by Hun agents and confederates among us. They are busy in that direction already. But be sure of this: Nothing—nothing we may have to endure now will weigh one featherweight compared with what we shall most certainly have to suffer if for any cause we fail of victory.

DR. DOUGLAS' MUNIFICENT BEQUEST TO THE INSTITUTE

Dr. James Douglas, who is memorialized on another page of this Bulletin, who held a place in the affections and regard of Institute members second to that of no other living man, left in his will the sum of $100,000 for the maintenance of the Library of the American Institute of Mining Engineers. This is in addition to the $100,000 which Dr. Douglas gave during his lifetime. We believe that it is Dr. Douglas' wish that the library, the great means by which the benefits of Institute membership may be extended to those distant from headquarters, should be maintained by the Institute at the highest possible level of efficiency and serviceability.

MINING AND METALLURGICAL INDEX

With this issue of the Bulletin, the Institute puts into operation a plan which it has long had under consideration for enlarging its field of usefulness to its members. We refer to the Index to periodical literature bearing on mining, metallurgy, and related subjects, which will be found in the advertising section at the end of the Bulletin. The Index is printed on alternate pages so that anyone who desires to compile a card index can readily clip the items and paste them onto cards.

By its affiliation with the Engineering Societies Library, the Institute possesses unexcelled facilities for the preparation of this Index, since practically every important engineering or technical paper published anywhere in the world is regularly received by the library. The items for publication in the Index are first selected by the library staff, but their final approval and their order of arrangement remains in the hands of the editor.

A word should be said in explanation of the system of classification that has been adopted. It will be noted that the classification is extremely broad, no attempt having been made to gather the references into closely specialized groups. Our reason for breaking away from the modern tendency toward minute specialization is based upon the fact that the fundamental principles underlying all engineering are not by any means so diversified as has commonly been supposed. For example, it is not at all unlikely that an engineer engaged in large-scale ore mining in the Southwest can profit by observing the methods employed by his colleagues in the Pennsylvania coal mines. It is notorious also how extensively the brotherhood of chemical engineers has profited by the earlier experiences of the ore-dressing and metallurgical engineers. If the Index were minutely sub-divided, it would always be possible that the coal-mining engineer, for example, might fail to observe a most important paper because it happened to be listed under the head of iron mining. For this reason, mining practice in general is consolidated under one head. The same line of reasoning applies to other divisions as well.

In order to make the Index of practical value to all members of the Institute, wherever they may be situated, the library will undertake to supply, for a nominal charge, an abstract, a translation, a typewritten copy, a photostat copy, or the original of any article in the Index. Requests for service of this character should be addressed directly to the Engineering Societies Library, 29 West 39th St., New York.

Members are urged to coöperate toward the success of this new departure by sending us suggestions. Although every effort has been made to anticipate the wishes of the members, it is almost impossible to foretell what services may be most useful to our 7000 constituents. Furthermore, it is known that some men prefer one method of classification while others would find another method more convenient.

We ask members to bear in mind that this work is costly, and that the efforts of the Secretary during several years to get the Index started have been opposed by those who declared that it was beyond the financial ability of the Institute to carry it through. The Secretary believes that the Index will become so valuable to our members that the necessary expense will be deemed justifiable by the Board of Directors, and he hopes that the plan may be expanded to still greater usefulness to the members distant from headquarters, as soon as we have had an opportunity to

prove its value. Numerous bibliographies, indexes, and systems of abstract have been attempted in the past, but few have survived, the chief cause of failure having been financial. Do the engineers desire services of this kind enough to justify the Institute in continuing the work?

As we go to press, the Editors already have in mind certain changes in the style of presentation, aiming to facilitate reference to the Index, which will be put into effect in the next issue.

FOURTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

Present indications are that the Fourth National Exposition of Chemical Industries, to be held in Grand Central Palace, New York, Sept. 23 to 28, will be the greatest exhibition of its kind ever held. Preparations are well under way and the advisory committee is working hard to make every department of the affair a success.

Men prominent in the chemical and allied industries will speak on subjects vital to present conditions and needs. Dr. C. H. Herty, and Dr. G. W. Thompson, President of the American Institute of Chemical Engineers, are to make opening addresses. F. J. Tone, President of the American Electrochemical Society; Dr. W. H. Nichols, President of the American Chemical Society, and several others, are expected to make addresses also. Prof. Joseph W. Richards will speak on "Ferro-alloys of silicon, tungsten, uranium, vanadium, molybdenum, and titanium." Theodore Swann, President of the Southern Manganese Corporation will speak on "Ferro-manganese."

The program for the exposition is in active preparation. There will be a series of symposiums on the "Development of Chemical Industries in the United States, notably since July, 1914." Among other topics for consideration is that of potash development; C. A. Higgins, of the Hercules Powder Company, will speak of the operations of that company in the recovery of potash from kelp; Linn Bradley, of the Research Corporation, on its recovery from cement dust, and other sources, by electrical precipitation.

Other symposiums will be devoted to chemical engineering, acids, industrial organic chemistry, the ceramic industries, and the metal industries. Among the speakers are:

A. Hough.—"Chemical Engineering in Explosives: TNT; TNA; Picric Acid; and Nitrobenzol."
E. J. Pranke.—"Development of Nitric Acid Manufacture."
S. P. Sadtler.—"Development of Industrial Organic Chemistry."
Geo. H. Tomlinson.—"Wood as a Source of Ethyl Alcohol."
C. A. Higgins.—"Kelp as a Source of Organic Solvents."
Alcan Hirsch.—"Pyrophoric Alloys."

The American Ceramic Society, which will hold its meeting at the Exposition on Thursday afternoon, Sept. 26, has already upon its program the following:

A. V. Bleininger.—"Recent Developments in the Ceramic Industries."
L. E. Barringer.—"Manufacture of Electrical Porcelain" (illustrated by motion pictures).
H. Ries.—"American Clays."
F. A. Whitaker.—"Manufacture of Stoneware" (illuminated).

Following this meeting a series of motion pictures of the ceramic industries will be shown. There will also be a series of motion pictures depicting lakes, water-falls, and hydroelectric power possibilities. The development of some of these will be carried through the several stages of construction, generation, and transmission of the power, and its use in industrial operations. Films of several electrochemical operations will be shown.

There will be pictures of many chemical, mining and related industries, and the application of electricity and electrical equipment to industrial work. There will be pictures showing the alkali industries; the making of glass, pottery and stoneware; the oil industries, petroleum, asphalt, fatty oils, soaps, paints, linoleum and oil cloth. There will be a series of films depicting carelessness, the destruction of life, wealth and resources, the hazards and risks in industrial plants and how they may be overcome. The dangers of fire and explosives will be demonstrated and the prevention of disease by vaccines.

TRANSACTIONS FOR 1918

Volumes 57 and 58 of the *Transactions* were mailed together during the third week of August to all members whose dues for 1918 had been paid on Aug. 1. Any member whose copies fail to reach him within a reasonable time is requested to notify the Secretary.

Volume 59 is on the press, and will be ready for distribution early in October.

PERSONAL

The following is an incomplete list of members and guests who called at Institute headquarters during the period July 11, 1918 to August 11, 1918.

John Carter Anderson, Tucson, Ariz.
Lieut. Frank A. Ayer, Tyrone, N. M.
W. R. Canton, McGill, Nev.
Alden Crankshaw, Palmerton, Pa.
John Davenport, W. Norfolk, Va.
A. Faison Dickson.
F. A. Fahrenwald, Cleveland, O.
L. Hall Goodwin, New York.
W. H. W. Hamilton, Baker, Ore.
Floyd D. James, St. Louis, Mo.
George A. Laird.
J. W. McBride, Spokane, Wash.
Arthur Notman, Bisbee, Ariz.
Edson S. Pettis, San Francisco, Cal.
Wm. H. Rettie, Yonkers, N. Y.
J. T. Robertson, Port Richmond, S. I.
Harry O. Robinson, Margarita, Venezuela.
C. K. Seng, Gilbert, Minn.
E. S. Sheffield.
H. G. Smith.
Harry M. Spoor.
H. H. Stoek, Urbana, Ill.
Arthur L. Tuttle, Copperhill, Tenn.
Thor Warner, Phoenix, Ariz.

Christopher G. Atwater, Manager Agricultural Dept., The Barrett Co., is in Washington serving the U. S. Navy Bureau of Ordnance in connection with the Navy nitrate plant recently authorized by Congress.

Edward Ludlam Blossom announces his marriage to Mabel Townsend, daughter of Mr. and Mrs. George Comings Mills, on Wednesday, July 17, 1918, at New York City.

Camphuis, Rives & Gordon, Inc., announce the opening of their New York office at 81 New Street, under the management of Mr. William D. Gordon, president of the company.

E. J. Carlyle is located, until further notice, with the British America Nickel Corporation, Ltd., at Sudbury, Ontario.

N. H. Darton of the United States Geological Survey will spend August and September in New Mexico, continuing his investigation of stratigraphy of the Red Beds especially as to their prospects for containing potash deposits.

A. De Deken is at present occupying the position of chief engineer with the Cia. Franco-Espanola de Minas, 93 Paseo de Gracia, Barcelona, Spain.

Emil A. Franke has resigned his position with the Cerro de Pasco Mining Co. of Peru, S. A. He is returning to the United States for service in the Ordnance Dept.

J. Hall Goodwin has accepted the position of field engineer with Rogers, Mayer & Ball, of 42 Broadway, New York City.

G. L. Grosvenor is now employed by the Cons. Arizona Smelting Co. at Humboldt, Ariz.

Robert M. Keeney announces change in his address to The Iron Mountain Alloy Co., P. O. Box 186, Denver, Colo.

C. R. Kuzell, formerly with the Anaconda Copper Mining Co. is asst. supt. of the United Verde Copper Company's Smelter of Clarkdale, Ariz.

Frederick Mac Coy has accepted a position with the United Verde Copper Co. at Jerome, Ariz.

W. G. Miller and R. W. Brock on a postcard received at Institute Headquarters, dated London, July 4, 1918, say "We are celebrating to-day. Uncle Sam is doing fine."

Redick R. Moore is now situated at Monterey, Mexico, with the American Smelting & Refining Co.

Douglas Muir is now holding the position of superintendent at the Aztec mines, Baldy, N. M.

Felipe B. Oré has accepted a position with the Ray Consolidated Copper Co. at Ray, Ariz.

C. J. Price announces that he has temporarily changed his address from Topeka, Kas., to Burnet, Tex.

L. B. Pringle, formerly chief chemist and experimental engineer for the Bonne Terre Division of the St. Joseph Lead Co., Bonne Terre, Mo., is now office manager of the Varnish Division of the Certain-teed Products Corporation, St. Louis, Mo.

Dan Reichel informs us that his new address is Hamburg, California, care the Scrad Chrome mine.

Donald D. Riddle has accepted a position with the Midwest Refining Co. and his present address is 819 First National Bank Bldg., Denver, Colo.

J. A. Rule writes us that he is at present assistant superintendent for the United Verde Extension Smelter, at Verde, Ariz.

William C. Schmidt, Jr., announces his marriage to Alice, daughter of Mrs. Willett Miller Tilley, on Monday, July 1, 1918, at Sea Cliff, N. Y.

Mortimer A. Sears has removed his offices from Paintsville, Ky. and is now located at 505 First National Bank Bldg., Huntington, W. Va.

D. R. Semmes has accepted a position as geologist with the Midwest Refining Co., Denver, Colo.

Edward L. Stenger has resigned from the United States Smelting, Refining, and Mining Exploration Co. and has accepted the position of assistant superintendent with the Mountain Copper Co., Ltd., Iron Mountain, via Keswick, Shasta Co., Cal.

Thomas A. Stroup has resigned his position with the Mineral Products Corporation and is now assistant engineer of the Utah Fuel Co., at Clear Creek, Utah.

Henry M. Sutton, Walter L. Steele, and **Edwin G. Steele** have resigned from the Minerals Milling Co., Van Horn, Texas, and have opened an office at Dallas, Texas, under the firm name of Sutton, Steele & Steele.

D. R. Thomas has secured a temporary position with the American Cyanamid Co., Niagara Falls, Ontario, Canada.

J. C. Vivian has severed his relations with the Huelva Copper and Sulphur Mines, Limited, in order to join the technical staff, in Spain, of The Tharsis Sulphur and Copper Co., Limited.

Harold E. Willson, formerly engineer for the Two Rivers Coal Co. and the Mission Mining Co., of Danville, Ill., advises that he is now superintendent for the Rothwell Coal Co., of Dubree, W. Va.

Herbert Wirshing has recently made a change in position and is now with the Selby Oil & Gas Co. at Tulsa, Okla.

A. Yates is now with the Ministry of Munitions, Zetland Hotel, Saltburn-by-the-Sea, Yorkshire, England.

POSITIONS VACANT

High-type research metallurgist with approximately following qualifications: American, 30 to 45 years old. Mind—Analytical. Education—college graduate. Practical shop experience—not less than 5 years. Metallurgical experience in steel making—at least 5 years. Chemical experience—should have some chemical training. Research ability—should be the type of man who is interested in new developments or research work. No. 337.

Engineer with some underground experience who is physically able to spend a large portion of his time underground, to act as general efficiency engineer. He will have cost keeping on special work, charge of contracts, labor distribution, etc. No. 338.

The services of a man experienced in flotation and familiar with the Callow apparatus are required for a short engagement in South America. No. 339.

A position as surveyor and draftsman for mines in Mexico is open. Opportunity for advancement. Climate pleasant and healthful. Knowledge of Spanish required. No. 340.

The Bureau of Construction and Repair, Navy Department, Washington, D. C., is in need of a few draftsmen of experience for work in connection with the development of industrial yards and shops of the Navy, under the cognizance of the Shore Establishment Division of the Bureau of Construction and Repair. Training in one of the following courses would be considered a requisite qualification:

Architecture; Architectural engineering; Civil engineering; Mechanical engineering; Industrial engineering.

The salary attached to these positions would be governed more or less by the qualification of the applicants; approximately $1800 to $2000 a year is contemplated. The bureau would be pleased to receive the names and qualifications of any men who have the requisite qualifications and who would desire appointment in Washington in capacities similar to that mentioned. No. 341.

The Government requires a draftsman for plotting cost and progress curves and a mechanical engineer for progress and cost reports for a period of eight months or longer. Salary, $175 per month; hours, 8:30–5:00. No. 342.

The Civilian Personnel Section, New York District Ordnance Office, requires engineers of tests and metallurgists for the Ordnance laboratories in Pittsburgh. No. 343.

The Department of the Interior requires technically trained persons for the examining corps of the Patent Office. Those having a scientific education, particularly in higher mathematics, chemistry, physics and French or German, and who are not subject to the draft for military service are desired. Engineering or teaching experience in addition to above is valued. Entrance salary, $1500.

Examinations for the position of assistant examiner are held frequently by the Civil Service Commission at many points in the U. S. Details of the examinations, places of holding, etc., may be had upon application to the Civil Service Commission, Washington, D. C. or to above department.

Should the necessity arise, temporary appointments of qualified persons may be made pending their taking the Civil Service examination. Application for such appointment should be made to J. G. Newton, Commissioner of Patents, United States Patent Office, Department of the Interior, Washington, D. C. No. 344.

ENGINEERS AVAILABLE

(Under this heading will be published notes sent to the Secretary of the Institute by members or other persons introduced by members.)

Member, age 31, technical graduate, 8 years' experience in copper and nickel mining, desires to make a change. No. 480.

Member, age 34, married, 16 years' experience as railroad construction engineer and as superintendent of iron, chrome and manganese mines. Especially successful in rush construction work and development of new mining properties. No straight salary proposition will be considered. No. 481.

Member desires change of position. Four years experience in flotation, cyaniding, and mill design and construction. Married, technical graduate. No. 482.

Member, age 33, married, graduate Columbia School of Mines. Nine years' experience as engineer and mining and oil geologist; experience in Mexico, Peru and Siberia. Speaks Spanish and Russian. No. 483.

LIBRARY

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF MINING ENGINEERS
UNITED ENGINEERING SOCIETY

HARRISON W. CRAVER, *Director*

The library of the above-named Societies is open from 9 A.M. to 10 P.M. except on holidays. It contains about 70,000 volumes and 90,000 pamphlets, including sets of technical periodicals and publications of scientific and technical societies.

Members of the Institute, with few exceptions, are forced to spend a portion of their time in localities isolated from sources of information. To these the Library, through its Library Service Bureau, can render valuable service through correspondence; letters requesting information will receive especial attention. The Library is prepared to furnish references and photographic copies of articles on mining and metallurgical subjects; to determine the existence of mining maps, and to furnish general information on the geology and mineral resources of all countries.

All communications should be made as definite as possible so that the information received may be what is desired and not include collateral matter which may not be of interest. The time spent in searching for such collateral matter will be saved, and the information will be sent more promptly and in more usable shape.

Library Accessions

COURS DE MÉCANIQUE. Vols. 1–4. By L. Guillot. Paris, 1911, 1913, 1918.

Extracting Nitrogen from the atmosphere at a power cost of over 221 tons per day for a 1000 kilo-watt power plant (equivalent to over 5,950,000 cubic feet of Nitrogen gas) or 248 cubic feet for one kilo-watt hour. Ed. 5. By J. F. Place. Glenridge, N. J., 1918. (Gift of author.)

Girard Estate. Report of the Mining Engineer and Agent. 1917. (Gift of Girard Estate.)

Pennsylvania Department of Mines. Report. Part II—Bituminous 1916. Harrisburg, 1917. (Gift of Pennsylvania Printing Dept.)

Petroleum, Asphalt and Natural Gas. (*Bulletin* No. 14, Kansas City Testing Laboratory.) Kansas City, 1918. (Gift of Dr. Roy Cross.)

PERU. A series of topographic and geologic maps, gift of the Sociedad Geografica de Lima, as follows:

Departamento de Loreto; Estudios verificados en 1906 en la region central del Peru; rio Putumayo; rio Napo; rio Bajo Marañon; rio Serjali; Mapa del Peru; la Previncia de Pacasmayo; rio Ucauali; Alte Perús y el Alte Yurúa; ries Pachitea y Pichis; rio Tigre; Lago Titicaca; ries Pastaza, Morena y Tigre; Vias de comunicacion entre Paita, Eten y el Marañon; ciudad del Cuzco; rio Huallaga; rio Tambopata; Mapa historico y geografico de Paucartambo; rio Pastaza; rio Manu; carte geologico de Casma y Chacas; la region oriental del Peru; rio Ueayali; carte geologico de las inmediaciones de Morococha; croquis de los rios Napo y Putumayo; rio Muorona; mapa de la navegacion del Alto Marañon; croquis del alto Ucayali y Bajo Urubamba; rio Amazonas Peruano.

RED CROSS INSTITUTE FOR CRIPPLES AND DISABLED MEN. Placement technique in the employment work of the Institute. By Gertrude R. Stein. (Publications, Series I, No. 9.)

——, RELATION OF THE SHORT, INTENSIVE INDUSTRIAL SURVEY TO THE PROBLEM OF SOLDIER RE-EDUCATION. By G. A. Boate. (Publications, Series I, No. 10.)

——, TRAINING IN ENGLISH TECHNICAL SCHOOLS FOR DISABLED SOLDIERS. By John C. Faries. (Publications, Series I, No. 11.)

——, VOCATIONAL SCHOOL FOR DISABLED SOLDIERS AT ROUEN, FRANCE. By J. Breuil. (Publications, Series I, No. II.)

Book Notices

Unless otherwise specified, books in this list have been presented by the publishers. The Institute does not assume responsibility for any statements made; these are taken from the preface or the text of the book, unless otherwise noted.

CONCRETE ENGINEER'S HANDBOOK. Data for the design and construction of plain and reinforced concrete structures. By George A. Hool and Nathan C. Johnson, assisted by S. C. Hollister, with chapters by Harvey Whipple, Adelbert P. Mills, Walter S. Edge, A. G. Hillberg, and Leslie H. Allen. 1st edition. N. Y., McGraw-Hill Book Co., Inc., 1918. 23 + 885 pp., illus., pl., tab., diag., 9 × 6 in., flexible cloth, $5.

This work has been prepared to make available in concise form the best present knowledge concerning concrete and reinforced concrete, and to present complete data and details, as well as numerous tables and diagrams, for the design and construction of the principal types of concrete structures.

ENGINEERING FOR MASONRY DAMS. By William Pitcher Creager. 1st edition. N. Y., John Wiley and Sons, Inc., 1917. 11 + 237 pp., 88 illus., 1 pl., 25 tab., 9 × 6 in., cloth, $2.50.

Investigations and Surveys. The Choice of Type of Dam, Forces Acting on Dams, Requirements for Stability of Gravity Dams, General Equations for Design of Gravity Dams, The Design of Solid, Non-overflow Gravity Dams, The Design of Solid Spillway Gravity Dams, The Design of Hollow Dams, The Design of Arch Dams, Preparation and Protection of the Foundation, Flood Flows, Details and Accessories.

Presents the theory and the fundamental assumptions of design of dams of this kind, and gives a number of examples showing the application of theory to practical designing.

INTERNATIONAL MINING LAW. By Theo. F. Van Wagenen. 1st edition. N. Y., McGraw-Hill Book Co., Inc., 1918. 342 pp., 7 × 5 in., flexible cloth, $3.50.

Starting with an account of ancient mining laws and customs, the author gives a digest of the present mining laws of the world. Statistics of production in the leading countries are given to show the effect of various laws on the industry, and there are discussions of different features of the laws. Confined to metal mining; the laws having to do with coal, iron and non-metals are omitted.

THE CYANIDE PROCESS. Its Control and Operation. By A. W. Fahrenwald. 1st edition. N. Y., John Wiley and Sons, Inc., 1918. 10 + 256 pp., 37 illus., 1 folded pl., 1 folded chart, 27 tab., 7 × 4 in., flexible cloth, $2.

The object of the book is to furnish a laboratory guide, both for investigating a new ore and for conducting the laboratory of a mill, which will include the latest developments of the process and be sufficiently complete for ordinary needs.

DISEASES OF OCCUPATION AND VOCATIONAL HYGIENE. Edited by George M. Kober and William C. Hanson. Phila., P. Blakiston's Son and Co. 21 + 918 pp., 46 illus., 10 × 6 in., cloth, $8.

With the assistance of a large number of experts, the editors have endeavored to present the basic facts concerning diseases of occupation in such a way as to form a safe, convenient guide for physicians, employers, workmen, legislators, public-health officials and other interested persons.

MY REMINISCENCES. By Raphael Pumpelly. N. Y., Henry Holt and Co., 1918. 844 pp., 57 pl., 24 por., 13 maps, 9 × 6 in., cloth, 2 vols., $7.50.

Born in 1837, the author studied geology and mining engineering in Paris and Freiburg, and later led a busy life as a geologist, mining engineer and explorer for over half a century. His professional activities in Asia and America provided an abundance of information on these lands and many adventures and anecdotes, which are presented in an interesting fashion in this autobiography.

WEST VIRGINIA.—Detailed Report on Barbour and Upshur Counties and Western Randolph, by D. B. Reger, with an introductory Discussion of Deep Well Records, including the Deepest Well in the World, by I. C. White, and a Discussion of Deep Well Temperatures by C. E. Van Orstrand. 867 pages + CIV pages of introductory matter, and illustrated with 53 half-tone plates and 43 figures or zinc etchings in the text, accompanied with a separate case of topographic and geologic maps of the entire area in two sheets, one covering Barbour County, and the other Upshur County and the coal area of Randolph west from Big Laurel and Rich Mountains. The whole region is underlain by the Coal Measures in which are several valuable beds, all of which are described, analyzed, and their areas mapped in this Report. Price, including case of maps, $3.00. West Virginia Geological Survey, Morgantown, W. Va.

Revised Figure Showing Bituminous Coal Beds in West Virginia, zincograph section, 6 in. wide and 40 in. long, showing the names, number and intervals separating the coal beds of West Virginia, and extending from the top of the Dunkard Series to the base of the Pottsville Series, on the scale of 1 in. to 200 ft., compiled and revised to July 1, 1918, by Ray V. Hennen, Assistant Geologist. Price, 25 cents. West Virginia Geological Survey, Morgantown, W. Va.

FORTHCOMING MEETINGS OF SOCIETIES

Organization	Place	Date 1918
American Chemical Society	Cleveland, O.	Sept. 9–12
American Society of Sanitary Engineers	Chicago, Ill.	Sept. 3–5
National Petroleum Association	Atlantic City, N. J.	Sept.
American Institute of Mining Engineers	Colorado	Sept. 2–7
National Association of Stationary Engineers	Cincinnati, O.	Sept. 9–13
Association Iron, Steel, Electrical, Engineers	Baltimore, Md.	Sept. 9–14
British Iron and Steel Institute, Autumn Meeting	London, Eng.	Sept. 12–13
National Exposition of Chemical Industries	New York, N. Y.	Sept. 23–28
American Electrochemical Society	Princeton, N. J.	Sept. 30–Oct. 2
Institute of Metals Division, A. I. M. E.	Milwaukee, Wis.	Oct. 8–11
Iron and Steel Members, A. I. M. E.	Milwaukee, Wis.	Oct. 8–10
American Foundrymen's Association	Milwaukee, Wis.	Oct. 7–12
American Museum of Safety and Sanitation, Exposition	St. Louis, Mo.	Oct. 7–12
National Safety Council	St. Louis, Mo.	Oct. 14–17
Business Show	New York, N. Y.	Oct. 21–26

MEMBERSHIP

NEW MEMBERS

The following list comprises the names of those persons who became members during the period July 10, 1918, to Aug. 10, 1918.

ARCHER, EUGENE G., Assayer and Chem., Granby Cons. Min. Smelt. & Power Co., Anyox, B. C., Canada.
BAKER, ROBERT C.........Mech. Engr. and Draftsman, Moctezuma Copper Co., Nacozari, Son., Mexico.
BARNES, EDWARD A............Supt., Fort Wayne Works, General Electric Co., Fort Wayne, Ind.
BARNHART, EDWIN......Engr. of Tests, Bethlehem Steel Co., Sparrow's Point, Md.
BENSLEY, MAURICE D..............Pres. and Mgr., Frontier Brass Foundry, Inc., Niagara Falls, N. Y.
BRADLEY, JOHN C...........Met., The American Brass Co., Waterbury, Conn.
BRAGG, C. T.......Works Mgr., Michigan Smelt. & Refin. Co., Detroit, Mich.
BRYMER, GEORGE W.....Min. Engr., 922 Union National Bank Bldg., Scranton, Pa.
CHIVVIS, NORMAN.............Met. Engr., More-Jones Brass & Metal Co., 3144 North Broadway, St. Louis, Mo.
CRAWFORD, R. D..........Prof. of Mineralogy & Petrology, Univ. of Colorado, Boulder, Colo.
DALY, DAVID R.....Pres. and Gen'l Mgr., J. H. Gautier & Co., Jersey City, N. J.
DAVIS, ROBERT S....................................Min. Engr., Milton, Pa.
DEWITT, H. A........Min. Engr., Chiksan Min. Co., Chiksan, Chosen, Korea.
DICKSON, JAMES K., Min. Engr., New York & Honduras Rosario Min. Co., Amapala, Honduras, C. A.
DITTMANN, MATTHEW C.................Vice Pres., In charge of Operations, American Bronze Corporation, Berwyn, Pa.
EARDLEY, MEHRING V......Asst. Mgr., American Metal Co., 314 Frisco Bldg., Joplin, Mo.
EDWIN, JOHN............Co. A, 27th Engineers, A. E. F., Care Postmaster, N. Y.
EVERNHAM, C. C., Mexico Representative, Merrill Metallurgical Co., 121 Second St., San Francisco, Cal.
FERRON, ROBERT D.......Min. Engr., Braden Copper Co., Rancagua, Chile, S. A.
FLAHERTY, P. J., Vice Pres. and Gen'l Mgr., Johnson Bronze Co., New Castle, Pa.
FRANKLIN, FREDERICK H., Met. Chem., Saunders & Franklin, 184 Whittier Ave., Providence, R. I.
GARDINER, F. E., Chem. and Met., Dominion Bridge Co., Ltd., Montreal, Quebec, Canada.
GILLETT, H. W...Alloy Chem., U. S. Bureau of Mines, Morse Hall, Ithaca, N. Y.
GILLIGAN, FRANK P., Sec'y and Treas., The Henry Souther Engineering Co., 11 Laurel St., Hartford, Conn.
GOODMAN, FRANK B......................Supt., Montreal Min. Co., Hurley, Wis.
GRAY, ARTHUR W., Director of Physical Research, The L. D. Caulk Co., Milford, Del.
GUREVICH, LOUIS J.....Met., Asst. Physicist, Bureau of Standards, Washington, D. C.
HAMILTON, FLETCHER.........State Mineralogist of California, Ferry Bldg., San Francisco, Cal.
HÉRIVEL, ERNEST PHILIP, Mine Supt., Esperanza Min. Co., Apartado Postal No. 8, El Oro, Estado de Mexico, Mexico.
HIGASHI, SENTARO, Supt., Ikuno Mine, Mitsubishi Kogio-Kabushika Kaisha, Tajima, Japan.
HOWE, HARRISON E., Chem. Engr., Mgr., Commercial Dept., Arthur D. Little, Inc., 30 Charles River Road, Cambridge, Mass.
HUNNER, EARL E., Mgr., Iron Mines, M. A. Hanna & Co., 701–12 Fidelity Bldg., Duluth, Minn.
IBBETT, ARTHUR W., Min. and Mech. Engr., Trinidad Leaseholds, Ltd., 1 London Wall Bldgs., London, England.
JENNISON, H. C.............Ansonia Branch, American Brass Co., Ansonia, Conn.
JOHNSON, CHARLES W.............Gen'l Supt., Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
JONES, JESSE L..........Met., Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
KENNEDY, WILLIAM ARTHUR, Testing Engr., General Fire Extinguisher Co., 275 West Exchange St., Providence, R. I.

KITSUNEZAKI, ICHIRO, Min. Engr., Furukawa Min. Co., No. 39 Cazenbocho Azabuku, Tokyo, Japan.
KLAUSTERMEYER, CARL H., Head of Ore & Zinc Sales Depts., Grasselli Chemical Co., Guardian Bldg., Cleveland, Ohio.
KLEE, WILLIAM B., Pres. and Treas., Damascus Bronze Co., 928 South Ave., N. S., Pittsburgh, Pa.
LHERAUD, ALEXANDRE......Chief Min. Engr., El Solvado, Pta., Cordoba, Spain.
LOUDERBACK, GEORGE D., Prof. of Geology, University of California, 103 Bacon Hall, Berkeley, Cal.
McFARLAND, DAVID F., Assoc. Prof. of Applied Chem., University of Illinois, 155 Chemical Laboratory, Urbana, Ill.
MACPHERRAN, RALPH S.....Chem., Allis Chalmers Mfg. Co., West Allis, Wis.
MATHEWSON, C. H., Asst. Prof. of Met., Sheffield Scientific School, Yale Univ., New Haven, Conn.
METZGER, JULES P.....Vice Pres. and Works Mgr., The Leslie Co., Lyndhurst, N. J.
MILLER, H. C............Supt., Round Valley Tungsten Co., Bishop Inyo Co., Cal.
MILLER, SAMUEL W.............Prop., Rochester Welding Works, 349 Orchard St., Rochester, N. Y.
MOODY, WILBUR L....Geol., Southern Pacific Co., 1829 Berryman St., Berkeley, Cal.
MORRIS, ALBERT WOOD, Cons. Engr., Morris Engrg. Co., 54 Buckingham St., Springfield, Mass.
MUELLER, HENRY P., Pres., H. P. Mueller Brass Foundry, 215–19 Lombard St., St. Louis, Mo.
NEWMAN, D. F.........Min. Engr., Supt., U. S. Manganese Corpn., Elkton, Va.
OHERN, D. W....................Geol., Fortuna Oil Co., Oklahoma City, Okla.
OLSON, L. W....Factory Mgr., Ohio Brass Co., 16 Glenwood Blvd., Mansfield, Ohio.
PACK, CHARLES, Chief Chem. and Met., Doehler Die Casting Co., Court and Huntington St., Brooklyn, N. Y.
PANNELL, ERNEST V., Engr., The British Aluminium Co., Ltd., 60 Front St., W., Toronto, Canada.
PARSONS, WALTER H., Min. Engr. .... 625 Market St., San Francisco, Cal.
PENICK, WALTER L., Met. Engr., Hardinge Conical Mill Co., 501 Newhouse Bldg., Salt Lake City, Utah.
POMEROY, W. D...........Gen'l Mgr., The Goulds Mfg. Co., Seneca Falls, N. Y.
POMPEIA, JONAS, Engr., Comp. Morro da Mina, 87 Rua General Jardin, S. Paulo, Brazil, S. A.
PUTNAM, W. P., Met., Major, Ord. R. C., Inspection Div., Detroit Testing Laboratory, 674 Woodward Ave., Detroit, Mich.
RAE, ELMER, Met., Mgr. of Brass Foundry, Metal & Alloy Specialty Co., Inc., 25 Illinois St., Buffalo, N. Y.
RANKIN, E. L.........................Supt., U. S. Smelt. Co., Altoona, Kansas.
RHEAD, E. L., Lecturer, Met. and Assaying, College of Technology, Manchester University, Manchester, England.
ROAST, HAROLD J.....Met. Chem., The James Robertson Co., Ltd., Montreal, P. Q., Canada.
ROBERTSON, NORMAN A., Member and Mgr., John Robertson & Co., 133 Water St., Brooklyn, N. Y.
ROGERS, JOHN C., Min. Engr., Canadian Copper Co., Copper Cliff, Ont., Canada.
SCHLOSS, JOSEPH A.....Sec. L. Vogelstein & Co., Inc., 42 Broadway, New York, N. Y.
SCHOTT, MAX, Gen'l Mgr., Ohio & Colorado Smelt. & Refin. Co., Ltd., 822 Foster Bldg., Denver, Colo.
SHAW, JOHN E...Engr., Charge of Underground Development, Chile Exploration Co., Chuquicamata, Chile, S. A.
SPARE, CHARLES R., Vice Pres. and Gen'l Mgr., American Manganese Bronze Co., Holmesburg, Pa.
SPILSBURY, H. G.........Met. Engr., Metal & Thermit Corpn., 120 Broadway, New York, N. Y.
SPRING, L. W.........Chief Met., Crane Co., 836 So. Michigan Ave., Chicago, Ill.
STARR, FRANK E., Underground Foreman, Chile Exploration Co., Chuquicamata, Chile, S. A.
STEVEN, HAROLD A...Min. Engr., Mond Nickel Co., Ltd., Worthington, Ont., Canada.
STRACHE, WALTER, Examining Engr., Fundicion de Guayacan, Casilla 226, Coquimbo, Chile, S. A.
TABER, M. N......................Met., The National Supply Co., Toledo, Ohio.
TEETS, JOHN N., U. S. Naval Aviation Detachment, Co. 22, Mass. Institute of Technology, Cambridge, Mass.

WEBERT, LOUIS P....Chem., U. S. Naval Engineering Experiment Station, Annapolis, Md.
WELSH, LEROY G., Min. and Pet. Engr., Pennsylvania Exploration Co., Baker, Mont.
WETTSTEIN, THOMAS F......Mgr., Keokuk Plant, United Lead Co., Keokuk, Iowa.
WOOD, ROBERT F., Met. and Foundry Supt., The Sandusky Foundry & Machine Co., Sandusky, Ohio.
WORSDELL, ARTHUR..Mill Foreman, Barnes King Development Co., Kendall, Mont.

Associates

ALLAN, PERCY........................Treas., Jenkins Mfg. Co., Bloomfield, N. J.
ANDREWS, JOSEPH C....Ordnance Dept., U. S. A., 123 Vine St., New Britain, Conn.
BASSETT, GEORGE B., Pres. and Gen'l Mgr., Buffalo Motor Co., 2917 Main St., Buffalo, N. Y.
BERLINER, HENRY E., Eastern Representative, Michigan Smelt. & Refin. Co., Detroit, Mich.
BUNTING, C. E., Sec'y and Treas., The Bunting Brass & Bronze Co., Toledo, Ohio.
COCHRANE, JOHN H...............Prop., The Cochrane Brass Foundry, York, Pa.
COHEN, FRED W., Asst. Gen'l Mgr., Metal & Thermit Corpn., 120 Broadway, New York, N. Y.
DAVIES, RALPH V..................Chem., U. S. Cartridge Co., Lowell, Mass.
DOEHLER, H. H., Pres. and Gen'l Mgr., Doehler Die Casting Co., Court & Huntington St., Brooklyn, N. Y.
DOERIGHT, G. A........Pres. and Mgr., The Falcon Bronze Co., Youngstown, O.
DOYLE, JOSEPH A., Vice Pres., W. S. Rockwell Co., 50 Church St., New York, N. Y.
FRETZ, EDWARD S., Pres. and Gen'l Mgr., Light Manufacturing & Foundry Co., Pottstown, Pa.
JONES, ARTHUR.............Pres., U. S. Smelting Furnace Co., Belleville, Ill.
KARR, C. POWELL, Associate Physicist, Bureau of Standards, Washington, D. C.
KAUFMAN, E. C., Chem. and Met., Federal Metal Co., 6621 Morgan Ave., Cleveland, O.
KROUSE, GEORGE........................148–154 Morgan St., Jersey City, N. J.
MERRILL, ALDEN.................Chem., American Brass Co., Waterbury, Conn.
MITCHELL, L. S., Vice Pres. and Mngng. Director, The Robert Mitchell Co., Ltd., 64 Belair Ave., Montreal, Canada.
MOERL, FREDERICK.....Gen'l Foreman, Brass Dept., The Pullman Co., Pullman Car Wks., Pullman, Chicago, Ill.
MUELLER, F. A........First Asst. Chem., Union Pacific Railroad, Omaha, Neb.
NEBEL, MERLE L., Asst. Prof. Economic Geol., West Virginia University, Mechanical Hall, Morgantown, W. Va.
REIDENBACH, F. W., Vice Pres., Coates, Bennett & Reidenbach, Box 1042, Rochester, N. Y.
SCHMITZ, M. W., Gen'l Mgr. and Vice Pres., Union Brass & Metal Mfg. Co., St. Paul, Minn.
SCHREIBER, LEONARD G., Vice Pres. and Gen'l Mgr., The L. Schreiber & Sons Co., Box 18, Evanston Station, Cincinnati, Ohio.
SELIGMAN, ARTHUR, Importer and Exporter of Metals and Ores, 165 Broadway, New York, N. Y.
SHAW, HUBERT A., Met., Engrg. Dept., National Conduit & Cable Co., Hastings-on-Hudson, N. Y.
SHEELER, JOHN HOWARD...Prop. and Mgr., Sheeler Hemsher Co., Philadelphia, Pa.
SILLMAN, JOSEPH..............Pres., Michigan Smelt. & Refin. Co., Detroit, Mich.
STEVENS, THOMAS A..............Pres., Empire Mfg. Co., Ltd., London, Canada.
TYSON, GEORGE E.....................Supt., Penn. Hardware Co., Reading, Pa.
UNGER, MAGNUS.............Elect. Engr., General Electric Co., Pittsfield, Mass.
WAKEFIELD, FREDERICK W..........Pres., F. W. Wakefield Brass Co., Vermilion, O.
WALKER, THOMAS E., Supt., Crittall Casement Window Co., 685 Atwater St., E., Detroit, Mich.
WILSON, CHARLES H., Pres., Wilson-Maeulon Co., 781 E. 142d St., New York, N. Y.

Junior Associates

CHIANG, LU-CHENG.............................1017 Twelfth St., Golden, Colo.
DOWDELL, RALPH LEWIS, Met.............1462 Como Ave., West, St. Paul, Minn.
GALLUCCI, NICHOLAS FRANK......Student, Colorado School of Mines, Golden, Colo.
STRAND, HARRY W...Min. Engr., Great Northern Iron Ore Properties, Marble, Minn.
TAO, H. T.......................Student, Missouri School of Mines, Rolla, Mo.

Change of Status—Junior Associate to Member

HIGGINS, LARRATT T. . . . . Mill Met., Braden Copper Co., Rancagua, Chile.
STITT, J. B., Acting Foreman, Acid Dept., Braden Copper Co., Sewell, via Rancagua, Chile, S. A.

Change of Status—Junior Associate to Associate

CRITTENDEN, ZAR T., Min. Engr., Wilson Foundry & Machine Co., So. Saginaw St., Pontiac, Mich.
WAKENHUT, C. J. . . . . Geol., Carter Oil Co., Tulsa, Okla.

Total Membership, Aug. 10, 1918 . . . . **6973**

CHANGE OF ADDRESS OF MEMBERS

The following changes of address of members have been received at the Secretary's office during the period July 10, 1918 to August 10, 1918.

This list together with the list published in Bulletin Nos. 133 to 140, January to August, 1918, and the foregoing list of new members, therefore, supplements the annual list of members corrected to Jan. 1, 1918 and brings it up to the date of August 10, 1918.

ALLEN, A. W., *Engineering & Mining Journal*, 10th Ave. and 36th St., New York, N. Y.
ANDREWS, CLARENCE W., 2d Lieut., 12th Bat. Infantry Replacement Regiment, Camp Lee, Va.
APPLEGATE, J. S., Material Engr., Wagner Electric Mfg. Co., 6400 Plymouth Ave., St. Louis, Mo.
ARLUCK, A. A., Headquarters, 1st Corps of Artillery, A. P. O. No. 759, A. E. F., France.
AYER, FRANK A., 1st Lieut., 353d Aero Squadron, A. E. F., Care Postmaster, N. Y.
BAKER, JOHN M. . . . . Sheridan, Mont.
BARTON, JOE C. . . . . Unicoi, Tenn.
BLAKESLEE, FRANK A. . . . . 60 Vernon Street, Oakland, Cal.
BOISE, CHARLES W. . . . . 709–5th Ave., N., Jamestown, N. D.
BOUDWIN, WALKER J., Corp., Administrative Labor Co., No. 46 (Spanish) A. P. O. No. 713, A. E. F., France.
BRINGE, H. . . . . Care American Barium Co., 57 Post Street, San Francisco, Cal.
BRULÉ, FREDERICK J., Chief Engr., British America Nickel Corpn. Ltd., The Citizen Bldg., Sparks St., Ottawa, Canada.
BRUNEL, FRANK P. . . . . Maxwell Land Grant Co., Baldy, New Mexico.
BRUNTON, FREDERIC K. . . . . Met. Engr., Arizona Copper Co., Morenci, Ariz.
CALKINS, F. E. . . . . Miami, Ariz.
CARLYLE, E. J. . . . . British America Nickel Corpn., Ltd., Sudbury, Ont., Canada.
CARR, HENRY C. . . . . C. W. Pope & Co., 25 Broad St., New York, N. Y.
CHAPMAN, LEWIS C. . . . . Co. F, 604th Engineers, Washington Barracks, D. C.
CHASE, J. L., Cadet No. 2011205, Canadian Engrs., Guy St. Barracks, Montreal, P. Q., Canada.
CHEN, FAN . . . . Pao Hsiang Kungse, Chenchow, South Hunan, China.
CLARK, H. SMITH . . . . Co. E, 1st Regiment Replacement Engineers, Washington Barracks, D. C.
COLEMAN, W. H., Corp., Co. E, 23d U. S. Engineers, A. E. F., Care Postmaster, N. Y.
COOPER, CLAUDE H. . . . . . . Capt., C. A. R. C., 50th Artillery, Camp Eustis, Va.
COPELIN, L. S. . . . . 521 I. W. Hellman Bldg., Los Angeles, Cal.
CREMER, FELIX . . . . Casilla 1057, Santiago de Chile, S. A.
CURRIE, DAVID, Director General, National Salvage Council, Caxton House, Tothill St., Westminster, S. W. 1, England.
DAVIS, ROY H. . . . . 500 So. Linden Ave., Pittsburgh, Pa.
DE DEKEN, A., Chief Engr., Cia. Franco-Espanola de Minas, 93 Pasco de Gracia, Barcelona, Spain.
DE HORA, M. HERRERA . . . . Instructed to hold everything.
DE LANDERO, CARLOS F. . . . . 1ª Alamo, 4, Mexico City, D. F., Mexico.
DELANO, FREDERIC A., Major, Army Engr. Reserve Corps, A. E. F., Care Postmaster, New York.

DICKSON, R. H.....................1st Lieut., C. A. N. A., Fortress Monroe, Va.
DOBSON, D. I., Corp., Co. F, 310th Engineers, A. E. F., Care Postmaster, N. Y.
DORR, J. V. N.........Pres., The Dorr Co., 101 Park Ave., New York, N. Y.
DUB, GEORGE D., Bureau of Mines, Care War Mineral Investigation, Dept. of Interior Bldg., Washington, D. C.
DUNN, THEODORE S.................Capt., 538th Engineers, Camp Meade, Md.
EATON, LUCIEN, Capt., E. R. C., Provisional Co. 4, E. R. O. T. C., Camp Lee, Va.
ELY, FRED B...............................1st Lieut., Aviation Section, N. A.
EMRICH, JAY L...................................3221 Franklin St., Denver, Colo.
FAIRBAIRN, GEORGE ....Capt., 252d Co. Royal Engineers, B. E. F., France.
FASSETT, NEWTON C., Section 600, U. S. Army Ambulance Service, with the Italian Army, A. E. F.
FORD, HAROLD P. .... 1565 East 118th Street, Cleveland, O.
FRANKE, EMIL A......................... 3453 No. Lincoln Street, Chicago, Ill.
FRASER-CAMPBELL, E. ....2d Lieut., 180th Tunnelling Co., R. E., B. E. F.
GEE, J. EMERSON, Min. Engr., Indiana-Oaxaca Min. Co., la Guerrero No. 1, Oaxaca, Mexico.
GILBERT, DONALD C..........Co. L, 1st Replacement Regiment Engineers, Washington Barracks, D. C.
GILL, AUTHOR H...Ridley Park, Pa.
GOODWIN, L. HALL, Field Engr., Rogers, Mayer & Ball, 42 Broadway, New York, N.Y.
GORDY, S. B..............................41 Atwater Ave., Derby, Conn,
GREENE, FRANK CASANOVE...........................Box 216, Denver, Colo.
GREGORY, A. E....................................Hokitika, New Zealand.
GRIFFEN, FRANK W.............Holbrook Bldg., 58 Sutter St., San Francisco, Cal.
GROSVENOR, G. L.......................Cons. Arizona Smelt. Co., Humboldt, Ariz.
HANCE, JAMES H..........................505 D. St. N. W., Ardmore, Okla.
HANST, JOHN FABER......Ingersoll-Rand Co., Farmers Bank Bldg., Pittsburgh, Pa.
HARDINGE, HARLOWE..........Capt., Radio Dept., Signal R. C., A. E. F., France.
HART, GILBERT.................Empire Gas & Fuel Co., Box 14, Eureka, Kansas.
HAVLIN, T. N.......Capt., 138th Ordnance Depot Co., Las Casas, Porto Rico.
HAYDEN, WALLACE H...De Pue, Ill.
HELLER, ALFONCE H. ....Supt., Ohio Copper Co., Lark, Utah.
HOAAS, OLE G..........................1644 Taylor St., San Francisco, Cal.
HOATSON, JOHN...Box 202, Ajo, Ariz.
HOOD, OZNI P..........................1831 Irving St., N. W., Washington, D. C.
HOPPER, WALTER E......Bureau of Research, War Trade Board, Washington, D. C.
HOUSEHOLDER, E. ROSS, Co. L, 1st Regiment Replacement Engineers, Washington Barracks, D. C.
HOWE, JAMES V...........................1616 S. Boston St., Tulsa, Okla.
HOWE, R. E................Care Cananea Copper Co., Cananea, Son., Mexico.
HUSSISSIAN, KHOREN L.........................Instructed to hold everything.
IMHOFF, WALLACE G., Lieut., Asst. Engr., Airplane Motor Dept., Rich Field, Waco, Texas.
INGERSOLL, GUY E., Asst. Metal Min. Engr., Dept. of the Interior, Bureau of Mines, Crosby, Minn.
JOHNSON, J. D., Tech. Asst. Works Mgr., Chester Shipbuilding Co., Ltd., Chester, Pa.
JONES, CHARLES H., Met., Minerals Separation Co., Ltd., 62 London Wall, London, E. C., England.
KEENEY, ROBERT M.....The Iron Mountain Alloy Co., P. O. Box 186, Denver, Colo.
KELLOGG, LEE O....South American Development Co., 15 Broad St., New York, N.Y.
KELLY, FRANK J.................................Hussar, Alberta, Canada.
KENNEDY, GEORGE A..................2741 Federal Boulevard, Denver, Colo.
KITSON, H. W., Ensign, U. S. N. R. F., Room E, Quarters B, U. S. Naval Academy, Annapolis, Md.
LANAGAN, WILLIAM H............Major, Engr. R. C., Camp A. A., Humphreys, Va.
LEHMANN, CHARLES, Care Institution of Mining and Metallurgy, 1 Finsbury Circus, London, E. C., England.
LINDSEY, JAMES.............516 Chamber of Commerce Bldg., Portland, Ore.
LINN, T. I., Care Rev. H. L. Yee, Shantung Christian University, Tsinan City, Shantung, China.
LIST, ELMER......................Care Air Nitrates Corpn., Muscle Shoals, Ala.
LOVEJOY, JOHN M., Lieut., F. A. R. C., Saumur Artillery School, A. P. O. No. 718, A. E. F., France.
MCAFEE, DAN S..................The Dorr Co., 101 Park Ave., New York, N.Y.

McALLEN, JOHN L. . .Lieut., Co. B, 602d Engineers, A. E. F., Care Postmaster, N. Y.
McCONNELL, ROBERT E., Lieut., U. S. N. R. F., Room 6312, New Interior Bldg., Navy Dept., Washington, D. C.
MACCOY, FREDERICK.................United Verde Copper Co., Jerome, Ariz.
MACIA, JAMES H.............................Box 555, Tombstone, Ariz.
MAGNUS, BENJAMIN.......................Capt., Engineers Reserve Corps.
MATHER, T. W................Care Cerro de Pasco Copper Corpn., Lima, Peru.
MATTHEWS, CHARLES H., Care M. A. Hanna & Co., 1300 Leader News Bldg., Cleveland, O.
MEAD, HARRY L., Capt., Quartermaster Corps, N. A., A. E. F., Care Postmaster, N. Y.
MEAD, RICHARD, Corp. (Battery C, 101st F. A.) Artillery School of Instruction, A. P. O. No. 711, A. E. F., France.
MILDON, R. B..................Westinghouse Electric & Mfg. Co., Lester, Pa.
MILYKO, ALEXANDER.......Sgt., 19th Battery, F. A. O. T. C., Camp Taylor, Ky.
MINOR, C. E...................................Box BB, Douglas, Ariz.
MITCHELL, GEORGE, Gen'l Mgr., Jerome-Superior Copper Co., Clarkdale, Ariz.
MOGA, JOHN AUGUST..............9th Co. C. A. C. of C. B., Fort Monroe, Va.
MOORE, HOWARD WARREN, Care F. M. Townsend, 912 Higgins Bldg., Los Angeles, Cal.
MOORE, REDICK R... American Smelt. & Refin. Co., Monterey, N. L., Mexico.
MOORE, STANLEY R....Rosebery-Surprise Min. Co., Ltd., Sandon, B. C., Canada.
MUIR, DOUGLAS.......................Supt., Aztec Mines, Baldy, New Mexico.
NEGRU, JACQUES S., Pvt. No. 2504000, Railway Constr. Troops Depot, (Draft No. 76) Purfleet, Essex, England.
NELSON, H. C...................Pvt., Co. E, 314th Engineers, A. E. F., France.
NELSON, WALTER I.............................Balloon Co. 64, Arcadia, Cal.
NIEDING, BURTON B..................Carbon Hill Coal Co., Carbonado, Wash.
ORÉ, FELIPE B.........................Ray Cons. Copper Co., Ray, Ariz.
ORMSBEE, JAMES J......................................Box 693, El Paso, Tex.
OSBORNE, L. D......................Supt., Manganese Ass'n, Las Vegas, Nev.
OUGH, SYDNEY W., Care Mr. N. W. J. Gibson, 7 Officers' Quarters, Royal Arsenal, Woolwich, London, S. E. 18, England.
PAGE, E. R...............1st Lieut., A. S., Sig. R. C., Love Field, Dallas, Texas.
PAGE, WILLIAM K., 1st Lieut., Ord. R. C., Care Army Inspector of Ordnance, Dayton Metal Products Co., Dayton, Ohio.
PARKER, D. J., Mine Safety Engr., U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.
PEMBERTON, J. R.............................803 Mayo Bldg., Tulsa, Okla.
PERRY, RALPH G., Candidate, 26th Training Battery, Field Artillery, Central O. T. S., Camp Taylor, Ky.
PFOUTS, ELMER..........Butters, Divisadero, Dept. Mora z au, El Salvador, C. A.
PIPKIN, PHILIP H..........Lieut., 116th Engineers, A. P. O. No. 733, A. E. F., France.
PLUMMER, F. B..........................Box 156, Mineral Wells, Texas.
POND, WALTER F., Capt., Headquarters, 30th Engineers (Gas & Flame Regiment), A. E. F., Care Postmaster, N. Y.
PRICE, C. J......Gen'l Mgr., The Burnet-Texas Graphite Co., Burnet, Texas.
PRICE, HAROLD C., Lieut., C. A. R. C., 53d Ammunition Train, C. A. C., A. E. F., France.
PRICE, VIRGIL T.......10th Co., 164th Depot Brigade, Camp Funston, Kansas.
PRINGLE, LEWIS B., Office Mgr., Gregg Varnish Co., 197 E. Grand St., St. Louis, Mo.
RANKIN, JAMES J......................5 West 103d Street, New York, N. Y.
READ, J. BURNS, Capt., Ord. R. C., Inspection Div., 1647 Lamont St., Washington, D. C.
RHOADS, ALBERT E............................642 Book Bldg., Detroit, Mich.
REICHEL, DAN.............Care Seiad Chrome Mine, Hamburg, Siskiyou Co., Cal.
RETTIE, WILLIAM H........................32 Glover Ave., Yonkers, N. Y.
RIDDLE, DONALD D., Midwest Refin. Co., 819 First National Bank Bldg., Denver, Colo.
ROBERTS, JOHN R........................Box 938, Wichita Falls, Texas.
ROBINSON, HARRY O...........................Instructed to hold everything.
ROCCA, BERNARD T................Care Virginia Louise Min. Co., Pioche, Nev.
ROSS, CLYDE P., Photographic Dept., Military Aeronautics, 21 Crowninshield Road, Brookline, Mass.
ROUDABUSH, MARTIN A., 2d Lieut., Engrs. R. C., A. E. F., Care Postmaster, N. Y.
RULE, J. ARTHUR, Asst. Supt., United Verde Extension Smelter, Verde, via Clarkdale, Ariz.
DESAULLES, CHARLES A. H., Gen'l Mgr., American Smelt. & Refin. Co., Denver, Colo.
SANDERS, W. MURRAY............8009 Navaho St., St. Martins, Philadelphia, Pa.

SANFORD, CHARD O. .... Supt., Wilshire Bishop Creek Mine, Bishop, Cal.
SEARS, MORTIMER A., Geol. and Min. Engr., 505 First National Bank Bldg., Huntington, W. Va.
SEAMON, W. H., JR., Pvt., Co. A, 27th Engineers, A. E. F., via Postmaster, N. Y.
SETZ, GUSTAV .... Box 543, St. Louis, Mo.
SHEFFIELD, E. S., Min. and Pet. Engr., Standard Oil Co., of New York, 26 Broadway, New York, N. Y.
SMITH, F. G., Met., Ord. Dept., Inspection Div., Non-ferrous Met. Branch, 6th and B. Sts., N. W., Washington, D. C.
SMITH, FRANK A. .... 2d Bat. Ordnance Detachment C, Edgewood, Md.
SMITH, H. G. .... 103 So. Gunter St., Vinita, Okla.
SNEDAKER, EUGENE G., 1st Lieut., Co. D, 4th U. S. Engineers, A. E. F., Care Postmaster, N. Y.
SCANTLIN, W. L., Sales Engr., Ingersoll-Rand Co. of Ill., 1505 Peoples Gas Bldg., Chicago, Ill.
SOMMERVILLE, WILLIAM B., JR. .... Lieut., C. A. C., Fort Terry, N. Y.
SPICER, H. N. .... The Dorr Co., 101 Park Ave., New York, N. Y.
STAVER, W. H., Mine Mgr., E. J. Lavino & Co., Bomfim, Estado de Bahia, Brazil.
STEELE, EDWIN GOODWIN .... Sutton, Steele & Steele, Dallas, Texas.
STEELE, O. W. .... Burro Mountain Copper Co., Tyrone, N. M.
STEELE, W. L. .... Sutton, Steele & Steele, Dallas, Texas.
STENGER, EDWARD L., Asst. Supt., Mountain Copper Co., Ltd., Iron Mountain, via Keswick, Shasta Co., Cal.
STEWART, JOHN S. .... 42 Park Ave., West, Mansfield, Ohio.
STEWART, LLOYD L., U. S. Government Inspector, Care Hercules Powder Co., Berkeley, Cal.
STOLLER, F. E. .... 1777 Rosedale Ave., Cleveland, O.
STOTT, GEORGE E., Maatschappij lot Mijn, Bosh En Landbouer Exploitatie, Tandjong Poera, Langkat, O. K., Sumatra.
STROUP, THOMAS A. .... Asst. Engr., Utah Fuel Co., Clear Creek, Utah.
SUTTON, HENRY M. .... Sutton, Steele & Steele, Dallas, Texas.
SWEETSER, ARTHUR L. .... United States Public Service Reserve.
THOMAS, DAVID R. .... Care American Cyanamid Co., Niagara Falls, Ont., Canada.
THOMSON, EDWARD, Gen'l Mgr., Espada Mines Co., Hostotpaquillo, Jal., Mexico.
THROCKMORTON, H. .... 901 Powell St., San Francisco, Cal.
THURSTIN, ROBERT A. .... Lieut., Co. C, 308th Engineers, A. E. F., France.
TOYODA, HIDEKANE, Min. Engr., Furukawa Min. Co., Tateishi-Machi, Oitaken, Japan.
TREICHLER, H. E. ..... Care Canadian Copper Co., Creighton Mine, Ont., Canada.
TRUEX, ARTHUR F., Geol., Cosden Oil & Gas Co., 902 Cosden Bldg., Tulsa, Okla.
UDDEN, JON A. .... Geol., Sinclair Gulf Oil Co., Box 16, Cisco, Texas.
VISEL, C. E., Co. M, 1st Engineer Training & Replacement Regiment, Washington Barracks, D. C.
VIVIAN, J. C., The Tharsis Sulphur & Copper Co., Ltd., Agencia de Tharsis, Huelva, Spain.
WALTERS, CHARLES W., Ensign, U. S. Naval Air Station, St. Trojan, Cherante Inf're, France.
WALTER, RAYMOND A. .... 710 North 5th St., Reading, Pa.
WANVIG, JOHN D., JR. .... Box 617, Glendale, Ariz.
WELD, C. MINOT ... Dept. of the Interior, Bureau of Mines, Washington, D. C.
WELSH, L. G. .... 6925 Bennett St., Pittsburgh, Pa.
WENDEL, EDMUND .... 1st Lieut., Co. A, 113th Engineers, A. E. F., France.
WEYMOUTH, FREDERICK A. ..... Sales Met., Bethlehem Steel Co., So. Bethlehem, Pa.
WILLIAMS, EDWARD I. .... Candidate, 2d Training Co., C. A. C., Fort Monroe, Va.
WILLSON, HAROLD E. .... Supt., Rothwell Coal Co., Dubree, W. Va.
WIRSHING, HERBERT .... Selby Oil & Gas Co., 805 Kennedy Bldg., Tulsa, Okla.
WOLVERTON, F. M. .... Jefferson Barracks, Mo.
WRAMPELMEIER, E. L. S., Min. Engr. .... 2324 Piedmont Ave., Berkeley, Cal.
WRIGHT, FREDERIC E., Capt., Ord. R. C., War Industries Board, Washington, D. C.
WRIGHT, W. H., Capt., Engr. R. C., General Engineer Depot, War Dept., 1438 N. W. You St., Washington, D. C.
WROTH, JAMES S. .... 1st Lieut., Engrs. R. C.
WYLER, JOSEPH A. .... 4131 Harrison St., Washington, D. C.
YATES, A., Care Ministry of Munitions, Zetland Hotel, Saltburn-by-the-Sea, Yorkshire, England.
YEN, CHUANG .... Phelps Dodge Corpn., Tyrone, New Mex.
ZEIGLER, W. L. .... Index, Wash.

MEMBERS' ADDRESSES WANTED

Name.	Last address of Record from which Mail has been returned.
ASHMORE, E. P.	504 Sherbourne St., Toronto, Ont., Canada.
BARNARD, C. W.	North Chicago Hospital, 2551 N. Clark St., Chicago Ill.
BARNETT, WILLIAM J.	8 Waterloo Place, Pall Mall, London, S. W., England.
BOAS, ROSS H.	Highland Boy Mine, Bingham Canyon, Utah.
BODDINGTON, HENRY D.	Ruatan, Bay Islands, Spanish Honduras.
BROOKE, LIONEL	Minas del Tajo, Rosario, Sin., Mexico.
BROWNE, ARTHUR B.	Malleable Iron Fittings Co., Branford, Conn.
BRYANT, GEORGE W.	Apartado 86, Guanajuato, Gto., Mex.
BYERS, WHEATON B.	50 Hampton Hall, Cambridge, Mass.
CONOVER, M. J.	Hotel Bellevue, San Francisco, Cal.
DENNIS, PAUL J.	Bisbee, Ariz.
DETERT, WILLIAM F.	Jackson, Amador Co., Cal.
EHLERS, L. W.	2137 St. Louis Ave., St. Louis, Mo.
DEFARIA, C. C., Fiscal das Estradas, Rua Condo do Bomfim, No. 46,	Rio de Janeiro, Brazil.
FIELDING, SIR CHARLES	Belmont, Faversham, Kent, England.
HOVLAND, HENRY B.	Los Angeles Athletic Club, Los Angeles, Cal.
IMHOFF, ALEXANDER	Box 1548, Miami, Ariz.
KAY, DAVID NELSON.	Ray Cons. Copper Co., Hayden, Ariz.
KERNAN, THOMAS H., School of Mines, Experiment Sta., Univ. of Minnesota,	Minneapolis, Minn.
KLUGESCHEID, WALTER P.	616 W. 113th St., New York, N. Y.
KONSELMAN, ALBERT S.	Globe, Ariz.
LEVY, MILTON M.	525 Cache la Pouche St., Colorado Springs, Colo.
MAYCUMBER, W. R.	Chile Exploration Co., Chuquicamata, Chile.
NOGUES, DOMINGO	Tampico, Mexico.
PRIOR, CHARLES E.	La Blanca y Anexas Mina, Pachuca, Hdgl., Mexico.
ROBERTS, EDWARD J.	Gen'l Mgr., Nevada Pyramind Min. Co., Riverside Hotel, Reno, Nev.
ROGERS, B. C.	Box 233, Mullin, Tex.
ROSS, HERBERT W.	314 Pacific Ave., Piedmont, Oakland, Cal.
SIMPSON, KENNETH M.	57 Post St., San Francisco, Cal.
STICKNEY, WILLIAM H.	708 N. Center St., Reno, Nev.
TONG, SING KOW	404 W. 115th St., New York, N. Y.
VAN RENSSELAER, ARTHUR M.	119 E. 51st St., New York, N. Y.
WOO, W. K.	M 70 Sing Kong Li, Minghong Road, Shanghai, China.
YOUNG, LEWIS E.	619 W. Springfield Ave., Champaign, Ill.

NECROLOGY

(See also "Died in Service.")

The deaths of the following members were reported to the Secretary's office during the month July 10, 1918, to Aug. 10, 1918.

Date of Election.	Name.	Date of Death.
1910	Carnahan, R. B., Jr.	1918.
1911	Dodge, David C.	1918.
1901	Irving, John Duer	July 26, 1918.
1896	Mackay, Angus R.	1918.
1899	Righter, Thomas M.	July 12, 1918.
1915	Ringlund, S.	July 24, 1918.

CANDIDATES FOR MEMBERSHIP

APPLICATION FOR MEMBERSHIP.—The Institute desires to extend its privileges to every person to whom it can be of service. On the other hand, it is not desirable that persons should be admitted to membership in classes for which they are not qualified. Members of the Institute can be of great service if they will make a practice of glancing through the list of applicants and promptly notifying the Committee on Membership, or the Secretary of the Institute, of any persons whom they think should not be classified in accordance with the list given.

Applications Lacking Endorsement

Applications for membership have been received from Mr. Hogg, Mr. Teale and Mr. Wilkie, whose records are given below. These applications lack the necessary number of endorsers, but since these candidates live at some distance from the headquarters of the Institute, their records are published here in order that any members who are acquainted with them may be advised of the circumstances and may have an opportunity of writing to the Secretary endorsing these candidates.

Members

James Hogg, Euboea, Greece.
Proposed by P. D. Ahier.
Born 1871, Lanarkshire, Scotland. Hutchesontown Grammar School, Glasgow. Glasgow Technical College. Member, Institute of Min. and Met. and Federated Institute of Min. Engrs. 1890–95, Min. Apprentice, McCreaths & Stevenson, Glasgow. 1895–97, Underground Colliery Mgr., Podmore Hall Collieries, Staffordshire. 1897–1904, Mines Mgr., Aznalcollar Mines, Seville Sulphur & Copper Co., Seville, Spain. 1904–11, Mgr., Heredia Lead Mines, Linares, Spain. 1911–17, Mgr., Anglo-Greek Magnesite Co., Ltd.
Present position: Director and Mgr., Anglo-Greek Magnesite Co., Ltd.

Donald Cook Wilkie, Serembau, Federated Malay States.
Proposed by
Born 1879, Dundee, Scotland. Brothers' school, Penang, Straits Settlements; Baptists' School, Rangoon, Burmah; Donaldson's School, Dundee, Scotland; 1890–92, Wallacetown School, Dundee, Scotland. 1892–98, Mechanical and electrical construction and repair work; engr. experience; drafting room; shop at sea, Ross & Wilkie, Scotland. 1898–99, Asst. Engr., China Borneo Co., Ltd., Sandakan, B. N., Borneo. 1901–03, Salvage Dept., Tangong Pagar Dock Co., Ltd., Singapore. 1903–10, Engr., Pyritical Ore Installation, Sungei Besi recovery of tin stone from arsenical and sulphurous ores, The Straits Trading Co., Ltd., Sungei Besi, Malay States.
Present position—1910 to date: Supt. Engr., Linggi Plantations Ltd.

Associate

James Willie Teale, Euboea, Greece.
Proposed by P. D. Ahier.
Born 1882, Leeds, England. 1886–90, General education, Leeds School Board. 1890–95, Ossett School, near Wakefield. 1895–1902, Ossett Technical School, full engr. course, science and art, South Kensington, obtaining Advanced Certificates. Correspondence courses. 1898–1903, Apprenticed to Bradley & Craven, Ltd., Engrs., Iron & Brass Foundries, Wakefield, England. 1904–06, Asst. to mech. and elec. engr., Old Roundwood Collieries, Wakefield, England. 1907, Asst. to mech. and elec. engr., Hoyland Lilkstone Collieries, Ltd., Barnsley. 1908, Asst. to mech. and elec. engr., Bullcroft Main Collieries, Doncaster, England.
Present position: Mech. Engr., The Anglo-Greek Magnesite Co., Ltd.

The following persons have been proposed during the period July 10, 1918, to August 10, 1918, for election as members of the Institute. Their names are published for the information of Members and Associates, from whom the Committee on Membership earnestly invites confidential communications, favorable or unfavorable, concerning these candidates. A sufficient period (varying in the discretion of the Committee, according to the residence of the candidate) will be allowed for the reception of such communications, before any action upon these names by the Committee. After the lapse of this period, the Committee will recommend action by the Board of Directors, which has the power of final election.

Members

Edward John Albert, Toronto, Canada.
Proposed by A. G. Kirby, A. H. Brown, John A. Rice.
Born 1882, Ingham Mills, N. Y. Grammar and High Schools, Cleveland. International and American Correspondence Course. Four years, Toronto Technical School, chem., geol., mineralogy and met. Private instruction. 1899–1908, factory, office and field work, Ingersoll-Sergeant Drill Co. 1908–11, Eng. design and installation, Ingersoll-Sergeant Co. and Allis-Chalmers Bullock, Ltd., Western Canada. 1911–13, Eng. design and installation, Canadian Allis-Chalmers, Ltd., and Canadian General Electric Co., Cobalt and Porcupine Dist. 1913–15, Mgr. mining dept., Canadian Allis-Chalmers, Ltd., Toronto.
Present position—1915 to date: Mgr., mining and power dept., Canadian Allis-Chalmers, Ltd.

Frank D. Aller, Pueblo, Colo.
Proposed by E. P. Mathewson, P. A. Mosman, Judd Stewart.
Born 1867, Bushnell, Ill. 1887, E. Denver High School. 1902, Grad., Colorado School of Mines, M. E. 1897–1900, Chem., Perth Amboy plant, M. Guggenheim's Sons refinery. 1900–02, Chem., American Smelt. & Refin. Co., Antofagasta, Chili, S. A. 1909–14, Mgr., Gatico Min. Co., Gatico, Chili.
Present position—1902 to date: Ore purchasing agent, American Smelt. & Refin. Co., S. A.

Charles Armstrong Baker, Anaconda, Mont.
Proposed by W. H. Casto, Jr., Louis V. Bender, Bayard S. Morrow.
Born 1884, Ft. Madison, Iowa. 1899–1903, Grad., Ft. Madison Iowa High School. 1904–08, Grad., Missouri School of Mines, B. S. 1909, Sampler, Utah Copper Co., Garfield, Utah. 1910–13, Nevada Cons. concentrator & power house work.
Present position—1915 to date: Leaching foreman, leaching plant, Anaconda Copper Min. Co.

Harold Alexander Baxter, Tacony, Philadelphia, Pa.
Proposed by A. A. Stevenson, Orville C. Skinner, R. M. Bird.
Born 1887, Wilkes-Barre, Pa. 1909, Univ., of Michigan, B. Sc. 1909–11, Met. Eng., H. H. Franklin Auto Co., Syracuse, N. Y. 1911–13, Sales Dept. Met., Midvale Steel Co., Philadelphia, Pa. 1913–15, Asst. Supt.; 1915–17, Supt., Ordnance Treatment Dept., Midvale Steel Co.
Present position—1917 to date: Met. Eng. and Operation Supt., Tacony Ordnance Corpn.

Clarence Allen Botsford, Crested Butte, Colo.
Proposed by S. J. Kidder, D. B. Scott, H. P. Bowen, A. M. Howat.
Born 1885, Springville, N. Y. 1904, Grad., Griffith Institute, Springville, N. Y. 1904–06, Rodman, office asst., Engr. Dept., Centennial Copper Co., Allouez Min. Co., Old Colony Copper Co., Mayflower Min. Co., Calumet, Mich. 1906–09, Michigan College of Mines, Houghton, Mich., B. S. and E. M. 1909–13, Supt., Sombrero Development Co., Globe, Ariz. 1913 (summer), Engr., Miami Copper Co., Miami, Ariz. 1913–14, Engr. office, Globe, Ariz. 1914 (summer), Chem., Superior & Boston Copper Co., Copper Hill, Ariz. 1914–17, Engr., Ernestine Min. Co. and Mogollon Mines Co., Mogollon, N. M. 1917 (summer), Supt., Caribel Min. & Mill. Co., Red River, N. M.
Present position—1917 to date: Supt., Mogollon Mines Co.

Richard Stuart Burdette, San Antonio, Tex.
Proposed by E. Francis McCrossin, J. S. Shaw, J. C. Maben, Jr.
Born 1884, Edgewater, N. J. 1907, School of Mines, Columbia Univ., E. M. 1906, summer, civil eng. for Broderick & Wind Cons. Co., West Point, N. Y. 1907–08, shift boss, underground mill and cyanide, Mexico Mines of El Oro, Ltd., El Oro, Mex. 1908, Prospecting over S. W. of state, Jal., Mex. 1908–10, Asst. Supt., Keystone copper smelter, Tapalpa, Jal., Mex. 1910–11, Mgr., Utah Lead Min. Co., Montello, Nev.; also Deputy Mineral Surveyor, Utah. 1911–17, Prof. business for self, Guadalajara, Jal., Mex. 1915–16, Represented Carranza and Villa Governments, (not both at same time) on exportation of mineral products from Jalisco.
Present position—1917 to date: Capt., Ordnance, R. C.

George Nelson Collins, San Juancito, Honduras.
Proposed by Paul R. Cook, W. B. Longan, A. R. Gordon.
Born 1883, Akron, Ohio. 1890–99, Public schools, Toronto, Canada. 1899–1903, Home study and private tutor. 1903–04, Instructions in engrg. and surveying. 1903, Mucker, carman, miner, Calumet & Arizona Min. Co., Bisbee, Ariz. 1903–05, Hand driller, miner, machineman, Cananea Cons. Copper Co., La Cananea, Mex. 1906, Machineman, timberman, Green Gold & Silver Min. Co., Conchena, Mex. 1907, Shift boss, Reforma Min. & Mill. Co., Campo Morado, Mex. 1908, Shift boss, Mexico Mines of El Oro, El Oro, Mex. 1909, Shift boss, Amalgamated Gold Mines Co., La Luz, Mex. 1910, Contr., Backus & Johnson Min. Co., Casapalca, Peru, S. A. 1911, Prospecting star churn drill, Chile Copper Co., Chuquicamata, Chile, S. A. 1911–16, Shift boss, Penn Copper Co., Campo Seco, Cal. 1917, Shift boss, Cananea Cons. Copper Co.
Present position—1917 to date: Mine shift boss, New York & Honduras Rosario Min. Co.

Arthur Lacey Court, San Francisco, Cal.
Proposed by W. G. McBride, Walter Harris, Edward H. Nutter.
Born 1887, Manchester, England. 1904–06, Tutor. 1906–08, Municipal School of Technology, Manchester, England. 1908–12, Grad., Victoria Univ., Manchester, England, B. Sc., University certificate of special proficiency in engrg. subjects, 1913, Associate Member, Australian Institute of Mining Engineers. 1912–14. Engrg. staff, Asst. Engr., erection slime concentrator and installation mach.; 1914, Asst. in charge slime concentrator; 1914–15, Flotation foreman, in charge general flotation operations and experimental research; 1915–17, Asst. Supt., general met. operations, Sulphide Corpn., Broken Hill, N. S. W., Australia.
Present position—1917 to date: Member engr. staff, Minerals Separation, North American Corpn.

Charles Edwards, Murray, Utah.
Proposed by E. C. Hickman, C. W. Adams, B. N. Kilbourn.
Born 1882, Manchester, England. 1904, Grad., Univ. of Ill., B. S. 1904–07, Asst. Chem. and Assayer, National Plant, American Smelt. & Refin. Co., So. Chicago, Ill. 1907, Chem., Assayer and Bookkeeper, Amador Min. & Smelt. Co., Iron Mt., Mont. 1907–08, Asst. Chem., East Helena Plant, American Smelt. & Refin. Co., East Helena, Mont. 1908–09, Chief Chem., Idaho Smelt. & Refin. Co., Ponderay, Ida. 1909, Chem. and Sampler at mine and mill, Tinton Reduction Co., Tinton, So. Dak. 1911–12, Asst. Chem., Tacoma Plant, American Smelt. & Refin. Co., Tacoma, Wash. 1912–14, Asst. Chem., National Plant, American Smelt. & Refin. Co., So. Chicago, Ill.
Present position—1914 to date: Chief Chem. and Asst. Met., Murray Plant, American Smelt. & Refin. Co.

Oliver Jones Egleston, Salt Lake City, Utah.
Proposed by Sidney J. Jennings, L. D. Anderson, Ernest Gayford.
Born 1877, Wykoff, Minn. 1900, Minnesota School of Mines, E. M. 1900–01, Draftsman, George K. Fischer, Cons. Engr. 1901–18, Engr. dept., United States Smelt., Refin. & Min. Co.
Present position: Chief. Eng., United States Smelt., Refin. & Min. Co.

Frank Francett Espie, Upper Burma, Asia.
Proposed by T. E. Mitchell, Arthur W. Jenks, Allan B. Calhoun.
Born 1890, Adelaide. 1902–08, St. Peter's Collegiate School, Adelaide. 1908–13, Adelaide Univ. and South Australian School of Mines, graduating as Bachelor of

Engineering and Fellow, S. A. S. M. 1911, Underground, Golden Horseshoe Estates, Kalgoorlie; 1912, Timberman; 1913–14, Flotation plant, British Broken Hill Prop., Ltd., Broken Hill. 1914, Asst. surveyor, Burma Mines, Ltd.
Present position—1915 to date: Mine surveyor, charge of survey section, min. dept., Burma Mines, Ltd.

George Clark Gester, San Francisco, Cal.
Proposed by E. G. Gaylord, J. A. Taff, M. E. Lombardi.
Born 1884, Buffalo, N. Y. 1904–08, Univ. of Cal., min and geol., B. S. 1908–09, Asst. Instr. Mineralogy, Univ. of Cal. 1909–14, Geol., Southern Pacific Co. 1914–16, Geol., charge of exploration work, Peru, S. A., for Standard Oil Co., N. Y. 1916–17, Independent min. and geol. work.
Present position—1917 to date: Geol., Standard Oil Co.

Ernest Howard Greig, Northern Shan States, Upper Burma.
Proposed by T. E. Mitchell, Arthur W. Jenks, Allan B. Calhoun.
Born 1884, Scotland. 1898–1902, Brighton Grammar School, Melbourne, Vic., Australia. 1903–07, Grad., Melbourne Univ., M. E. 1908–10, Underground, Oroya Brownhill Co., milling dept., Lake View Consuls (Lake View & Star) Kalgoorlie. 1910–11, Surveyor, Vivien Gold Min. Co., Lawlers, W. Australia. 1911–12, Surveyor, head office, Bewick Moreing & Co., Kalgoorlie, W. Australia. 1912–15, Chief Mine Surveyor. 1916, Mine Foreman, Burma Mines, Ltd.
Present position—1917 to date: Asst. Mine Supt., Burma Mines, Ltd.

John A. Hendricks, Chuquicamata, Chile, S. A.
Proposed by James E. Bell, Warren D. Thompson, F. E. Starr.
Born 1889, Abeline, Kan. 1896–1904, Grammar school, Pomona, Cal. 1904–08, High school, Los Angeles, Cal. 1914, Univ. of California, Berkeley, Cal., B. S. 1909, summer, Eng. Dept., City of Los Angeles. 1910, summer, Harper-Hill Brick Co., Seattle, Wash. 1911, summer, Los Angeles aqueduct. 1912, United States Reclamation Service, Yuma, Ariz. 1913, summer, North Star mine, Grass Valley, Cal. and Gaston mine, Gaston Ridge, Cal. 1914, summer, Empire mine, Grass Valley, Cal. 1915–16, Surveying, sampling, assayer and specimen boss, cyanide plant, Empire Mines Co., Grass Valley, Cal.
Present position—1916 to date: In charge of sampling and assaying dept., Chile Exploration Co., Dept. of Mines.

Herreros P. Hector, Santiago de Chile, S. A.
Proposed by F. A. Sundt, I. Gandarillas, Berthold Koerting.
Born 1890, Ovalle. 1910, Lyceum of Serena. 1910–15, Univ. of Chile. 1916, Grad., Univ. of Chile, E. M.
Present position—1917 to date: Eng., The Chilian-Bolivian Mining Syndicate.

Austin Taber Hyde, Keokuk, Ia.
Proposed by R. G. Hall, J. A. Caselton, C. A. Grisham.
Born 1880, Boston, Mass. 1901, Grad., Mass. Inst. of Technology, B. S. 1901–02, Chem.; 1902–15, Asst. Supt.; 1915–17, Supt.; Fort Hill Chemical Co., Boston, Mass.
Present position: Mgr., Keokuk Plant, River Smelt. & Refin. Co.

Herman Norton Johnson, Salt Lake City, Utah.
Proposed by James F. Kemp, Walter Douglas, Horace V. Winchell.
Born 1879, Binghamton, N. Y. 1899, Grad., Binghamton Central High School. 1903, Amherst College, Amherst, Mass., B. A. 1906, Columbia School of Mines, New York, E. M. and M. A. 1906–07, Asst. geol., Anaconda Copper Min. Co., Butte, Mont. 1907, Asst. supt., Deerlodge mines, Deerlodge, Mont. 1907–10, Expert miner, United States Forest Service, chiefly in Mont., Utah, Ariz., and New Mexico. 1910–11, Geol., Progress mines of New Zealand. 1911–13, Gen'l Supt., Cons. Gold Fields of New Zealand. 1913–16, Geol., Burro Mt. Copper Co., Tyrone, New Mexico.
Present position—1916 to date: Geol., United States Smelt. Refin. & Min. Co.

Ernest C. Koch, Westmount, P. Q., Canada.
Proposed by T. E. Mitchell, Arthur W. Jenks, Allan B. Calhoun.
Born 1890, Chicago, Ill. 1911, McGill Univ., Montreal, B. Sc. 1909, Miner, Canadian Copper Co., Creighton, Ont., Canada. 1910, Experimental milling plant,

Cons. Min. & Smelt. Co., Moyie, B. C. 1911–14, Draftsman, asst. to underground mine mgr. and supt., charge of tunnel operations, Nova Scotia Steel & Coal Co., Wabana, Newfoundland.
Present position—1914 to date: Shift boss, Bawdwin mine, Burma Mines, Ltd., Namtu, Asia.

Edward William Lawler, Bayonne, N. J.
Proposed by R. B. T. Kiliani, Fred L. Wolf, A. P. Watt, H. W. Hardinge.
Born 1878, Jersey City, N. J. Pratt Institute, Brooklyn, N. Y. 1903–08, Salesman and eng., Abbe Engr. Co., New York, N. Y. 1908–11, Mgr., Hardinge Conical Mill Co., New York, N. Y. 1911–13, Supt., Kenilworth Rubber Co., defunct. 1913–15, Gaining experience, Worthington Pump Works; Engr. Salesman, Jeffrey Mfg. Co.
Present position—1916 to date: Mgr. Hardinge Conical Mill Co.

James McFarlane Little, Towanda, Pa.
Proposed by Charles P. Berkey, James F. Kemp, Alfred J. Moses.
Born 1885, Towanda, Pa. 1903–04, Civil Engr. course, Pennsylvania Military College, Chester, Pa. 1904–07, Columbia Univ., E. M. 1907, Eng., Salt Lake Copper Co., Tecoma, Nev. 1908, Eng., Octave Gold Min. Co., Octave, Ariz. 1908–09, Eng. constr., Phillips River Gold & Copper Co., West Australia. 1910, Engrg. Dept., Copper Queen Cons. Min. Co., Bisbee, Ariz. 1910–13, Geol. Dept., Cananea Cons. Copper Co., Cananea, Mex. 1913–14, Geol. survey of property, Moctezuma Arizpe Dev. Co., Cananea, Mex. 1915, Engrg. Dept., Braden Copper Co., Chile. 1916–17, Mine exam., M. Hochschild, Chile.
Present position: First Lieut., E. R. C.

Michael H. Loveman, Nam Tu, Northern Shan States, Burma.
Proposed by T. E. Mitchell, Arthur W. Jenks, Allan B. Calhoun.
Born 1888, Summit, N. J. 1906–09, Columbia Univ., A. B. 1909–10, M. A. 1910, Cleveland Min. Co., Hazel Green, Wis. 1911–12, Geol., Miami Copper Co., Miami, Ariz. 1912, Charge development of gold prospect, Osceola, Nev. 1913, Charge Cleveland Gold Min. Co., Dryden, Ont. 1913, Exam. work in Ont. and Tenn.
Present position—1914 to date: Chief Geol., Burma Mines, Ltd.

Edward E. McIntyre, Los Angeles, Cal.
Proposed by Alvin B. Carpenter, W. F. Staunton, C. O. Lindberg.
Born 1880, Flint, Mich. 1901, Grad., Michigan College of Mines. 1901–02, Eng., Oliver Min. Co., Hibbing, Minn. 1902–06, Min., personally owned properties, Sta. Barbara, Mex. 1906–08, Supt., Minas Tecotas y Anexas, Sta. Barbara, Mex. 1908–13, Mgr., Guanajuato Dev. Co., Guanajuato, Mex.
Present position—1913 to date: Cons. Engr.

Donald Robert MacKay, Leadwood, Mo.
Proposed by Benedict J. Baker, James A. Caselton, R. G. Hall.
Born 1888, Denver, Colo. 1903–07, North Denver High School. 1907–12, Colorado School of Mines, E. M. 1912-13, Electr., Excelsior Min. Co., Frisco, Colo. 1913–14, Chem., Arizona United Min. Co., Johnson, Ariz. 1915, Chem., El Rayo Development Co., Sta. Barbara, Mex. 1915-16, Miner, Tombstone, Ariz. 1916, Asst. eng., Detroit Copper Min. Co., Morenci, Ariz. 1916–17, Chem. and eng., Ellamar Min. Co., Ellamar, Alaska. 1917, Millman, Wallace and Mullan, Idaho.
Present position: Eng., Baker Lead Co., Leadwood, Mo.

Harry J. Meisel, Butte, Mont.
Proposed by W. D. Mangam, W. C. Siderfin, E. B. Young.
Born 1881, San Francisco, Cal. High School, San Francisco, Cal. 1898–99, Van der Naillen School of Mines, San Francisco, Cal. 1900, Falkenan Technological Laboratory, San Francisco, Cal. 1901, Asst. Supt., Great Western Quicksilver Min. Co., Cal. 1902–04, Assayer and chem., Rawhide Gold Min. Co., Cal. 1905–07, Min. Eng., New York Honduras Rosario Min. Co., C. A. 1908, Field asst., U. S. Geol. Survey. 1909, Supt., Rawhide Gold Min. Co., Cal. 1910, Mill supt., War Eagle Min. Co., Nev. 1911–14, Field eng., West End Cons. Min. Co., Nev. 1915, Supt., Independent Lead Silver Min. Co., Cal. 1915–18, Min. eng., Elm Orlu Min. Co., Butte, Mont.
Present position: Litigation and efficiency eng., Elm Orlu Min. Co.

Tomotoshi Nabeshima, Yabu-Gun, Hyogo-Ken, Japan.
Proposed by Shinji Harada, Ichiro Kamimura, C. Kato.
Born 1888, Saga-Ken, Japan. 1903–08, Middle School, Japan. 1908–11, High School, Nagoya, Japan. 1911–14, Tokyo Imperial Univ., Japan. 1914, Min. eng., Metal Min. Dept., Mitsubishi Co., Tokyo, Japan. 1914–16, Min. eng., Mitsubishi Akenobe Mine.
Present position—1916 to date: Supt. of mines, Mitsubishi Akenobe mine.

William Hunt Nutting, Anaconda, Mont.
Proposed by Frederick Laist, Louis V. Bender, Harry S. Ware.
Born 1859, Jacksonville, Ill. 1880, Assay office, Lake City, Colo. 1882–87, Assayer and chem., Elgin smelter, Leadville, Colo. 1888–90, Reporting on smelting propositions, several different places. 1891, Asst. to W. L. Austin, making pyritic test-run, Leadville, Colo. 1892–1900, Supt., Bi-metallic smelter, Leadville, Colo. 1901–06, Designed, built and operated, Bingham Copper & Gold smelter, Midvale, Utah.
Present position—1906 to date: Supt. of tramming and weighing dept., Washoe Reduction Works, Anaconda Copper Min. Co.

Raymond William Parsons, Grass Valley, Cal.
Proposed by Robert H. Bedford, Arthur B. Foote, John E. Hogan.
Born 1888, Grass Valley, Cal. 1902–06, Grass Valley High School. 1906–09, Univ. of California. 1909–13, Shiftman; 1913–14, Assayer; 1914–17, Foreman, cyanide plants, North Star Mines Co., Grass Valley, Cal.
Present position—1917 to date: Surveyor, North Star Mines Co.

Carl Bruno Peters, Washington, D. C.
Proposed by Charles H. Smith, Newell W. Roberts, C. T. Malcolmson.
Born 1887, Davos, Switzerland. Public and high schools, New York, N. Y. 1902–17, Dir., Treas. and Sec., Charles F. Garrigues Co., New York, N. Y.
Present position—1917 to date: Capt., U. S. R., Head Explosives Section, Procurement Div., U. S. Army.

James Gilbert Powell, Lew Hazelton, B. C.
Proposed by Arthur E. Hepburn, George A. Clothier, H. E. Clement.
Born 1889, London, England. 1895–1901, Chadwell School, Essex, England. 1901–02, Ilford High School, Ilford, England. 1902–06, Carpenters Technical Institute, Stratford, London. 1908–11, Prospecting and studying coal occurrences, Alberta, Can. 1911–12, Assayer, Mount Stephen Min. Co., Field, B. C. 1912–13, Hasquett Island Min. Co., and Red Cliff Min. Co., Stewart, B. C. 1913–16, Assayer, J. O'Sullivan, F. C. S., Custom practice, Vancouver, B.C.
Present position—1916 to date: Private practice as provincial assayer and chem.

Samuel Bruce Shutts, Lynchburg, Va.
Proposed by W. A. Stanton, B. G. Klugh, A. B. Hardie.
Born 1883, Joliet, Ill. Grad., Joliet Township High School. 1902–07, Stove-tender and foreman of blast furnace; 1907–17, Asst. Supt., blast furnace, Illinois Steel Co., Joliet, Ill. 1917–18, Supt., Marietta furnace, Lavino Furnace Co., Marietta, Pa.
Present position: Supt., Oriskany furnace, Lavino Furnace Co.

Wilhelm Trevor Swoyer, Sneedville, Tenn.
Proposed by Edward L. Dufourcq, Martin Fishback, Kirby Thomas.
Born 1874, Wilkes-Barre, Pa. 1891–94, Royal Min. Academy, Freiberg, Saxony, Germany. 1894–96, Royal Prussian Min. Academy, Clausthal, Prussia, Germany. 1896–97, Preliminary R. R. survey and asst. eng., Compania Metalurgica Mexicana, Sierra Mojada, Coah., Mexico. 1898–99, Eng., San Rafael y Anexas and Barones and Vicochea, Zacatecas, Mex. 1899–1900, Min. Eng., Kansas City Cons. Smelt. & Refin. Co., Santa Eulalia, Chih., Mex. 1901–05, Cons. Eng., Parral Mexico in firm Preusse & Swoyer & van Dreveldt. 1905, Gen'l Supt., Cia. Minera Ignacio Rodriguez Ramos, Cigarrero mine, Mex. 1906, Cons. eng., Mexico City. 1907, Mgr., Presidente mine, Naica, Chih., Mex. 1908–10, Mgr., New Year Min. Co. and Sierra Mojina Min. Co., Sierra Mojina, Chih., Mex. 1911–13, Mgr., Estella mine, Santa Eulalia, Chih. for Bainbridge, Seymour & Co. of London; Cons. eng., El Paso, Texas. 1913–14, Supt., Jarilla Copper Syndicate, Orogrande, N. M. 1915–16, Independent operator, White Oaks and Organ, N. M. 1916–17, Mgr., United Mines Dev. Co., Organ, N. M.
Present position—1917 to date: Chief Eng., Southland Exploration Co.

Seymour Paul Ward, McGill, Nev.

Proposed by R. E. H. Pomeroy, M. R. Hull, William A. McCay.

Born 1883, Tabriz, Persia. 1909, Grad., Ohio State Univ., Columbus, Ohio, C. E. 1904–05, Chem., Carnegie Steel Co., Zanesville, Ohio. 1905, Chem., Alma Cement Co., Wellston, Ohio. 1909–10, Ceramic eng., Big Four Clay Co., Canton, Ohio. 1910–11, Ceramic eng., Simons Brick Co., Los Angeles, Cal. 1911–12, Chief Chem., Durostone Co. of America, San Diego. 1912–16, High School Teacher, Los Angeles City Schools. 1916–17, Supt., Glendale Min. Mill & Power Co., Aurum, Nev. 1917–18, Ceramic and exp. eng., Nevada Cons. Copper Co.

Present position: Eng. in charge, Pulverized Coal Dept., Nevada Cons. Copper Co.

Walter Victor Wilson, Coulterville, Cal.

Proposed by Nelson Dickerman, Newton Cleaveland, F. A. Gowing.

Born 1891, Vallejo, Cal. 1910–12, Stanford Univ., Cal. 1913–15, Mgr., Moccasin mine, Moccasin Min. Co. 1915, Examining mines, G. E. Gamble, Cal., Nev. and Utah.

Present Position—1914 to date: Asst. Mgr., White Gulch Min. Co.

Associates

Chung-yang Chen, Erie, Pa.

Proposed by Charles E. Locke, Edward E. Bugbee, H. O. Hofman.

Born 1893, China. 1910–13, Tsing Hua College, Peking, China. 1914–18, Massachusetts Institute of Technology, S. B.

Present position: Inspector, American Brake Shoe and Foundry Co.

David Morey, Jr., A. E. F.

Proposed by J. B. Carlock, Edward Steidle, T. H. Beddall.

Born 1885, Troy, N. Y. 1891–1901, Public schools, Troy, N. Y. 1901–02, Troy Academy, Troy, N. Y. 1903–06, Rensselaer Polytechnic Inst., Troy, N. Y. 1906–07, General Electric Co., 1907–09, Chem. and bact., City of Harrisburg, Harrisburg, Pa. 1909, Chem. and bact., Metro. Sewage Commission, New York, N. Y. 1909–11, Supt., Water filtration, Penn. Water Co., Pittsburgh, Pa. 1911–12, Design of purification plants, Dallas, Texas. 1912–14, Res. eng., Dallas water purification plant. 1914–17, Supt., water purification, Dallas, Texas.

Present position: 1st Lieut. Engrs. U. S. R.

George L. Schmutz, Douglas, Ariz.

Proposed by John S. Williams, McHenry Mosier, S. A. Gardanier.

Born 1893, Cumberland, Md. 1907–11, Grad., Alleghany County High School. 1911–12, Student, Lehigh University. 1912–13, mucker and miner, Butte, Mont. 1914, Irrigation eng., Miller & Lux, Los Banos, Cal. 1914, City Eng., Niland, Cal. 1915, Asst. constr. eng., I. W. Co.-3, Calipatria, Cal. 1915–16, underground eng., Los Pilares mine. 1916, Miner, Bisbee and Globe, Ariz.

Present position—1917 to date: Member of firm, Schmutz & Rugen.

James Hammond Townsend, Kingman, Ariz.

Proposed by George W. Mark, R. C. Jacobson, G. W. Kays.

Born 1893, Los Angeles, Cal. 1910–12, Los Angeles High School. 1913, Univ. So. Cal. Prep. School. 1914, Univ. So. Cal. College of Law. 1915–16, Dir. Tungsten Mines Co., operating at Bishop and Kingman, Ariz. 1917, Operated manganese property near Ludlow, Cal.

Present position—1917 to date: Operating tungsten property.

Arthur A. Wheeler, Peru, S. A.

Proposed by Stuart L. Rawlings, E. E. Barker, J. T. Glidden.

Born 1892, Crested Butte, Colo. 1898–1904, Grade schools, Crested Butte & Denver, Colo. 1905–07, High schools, Denver, Colo. 1908–11, General Course; 1912, Chem. and math., Jesuit College, Denver, Colo. 1911, summer, millman, 1912, Assayer and millman, Revenue Tunnel, Sneffles, Colo. 1913, Amalgamator.

Liberty Bell Min. Co., Telluride, Colo.; Chem. and melter, Golden Flint Min. & Mill. Co., Rollinsville, Colo. 1914, 3 mo., bullion melter, amalgamator and millman, Liberty Bell Min. Co., Telluride, Colo.
Present position—1914 to date: Concentrator foreman and testing, Backus & Johnston Co.

Otto Leopold Yauch, Keewatin, Minn.
Proposed by W. E. Hopper, F. W. Sperr, Albert J. Houle.
Born 1895, Houghton, Mich. 1913–1916, Grad., Michigan College of Mines, Houghton, Mich., B. S. and E. M. 1916, Asst. Eng., Victoria Min. Co., Victoria, Mich. 1916–17, Min. Eng., Winona Copper Co., Winona, Mich.
Present position—1917 to date: Chief Eng., Bennett Min. Co.

Junior Associates

Wilbur Swett Burbank, Amesbury, Mass.
Proposed by Charles E. Locke, H. O. Hofman, Carle R. Hayward.
Born 1898, Amesbury, Mass. 1915, Mass. Inst. of Technology.
Present position—1915 to date: Student, Mass. Inst. of Technology.

Richard Sturtevant Everit, Barre, Mass.
Proposed by Charles E. Locke, H. O. Hofman, Carle R. Hayward.
Born 1897, Framingham, Mass. 1915, Mass. Inst. of Technology.
Present position—1915 to date: Student, Mass. Inst. of Technology.

George Grimes Heming, Boston, Mass.
Proposed by Charles E. Locke, H. O. Hofman, Carle R. Hayward.
Born 1896, Fort Riley, Kan. 1912–15, Phillips Exeter Academy.
Present position—1915 to date: Student, Mass. Inst. of Technology.

Frederick Lawther Peart, Cambridge, Mass.
Proposed by Carle R. Hayward, Edward E. Bugbee, Charles E. Locke.
Born 1895, Picton, Colo. 1910–14, Warren Academy. 1914–15, Univ. of Denver. 1915–16, Univ. of Pennsylvania.
Present position—1916 to date: Student, Mass. Inst. of Technology.

James Ward Reis, Jr., New Castle, Pa.
Proposed by Carle R. Hayward, Edward E. Bugbee, Charles E. Locke.
Born 1896, New Castle, Pa. 1902–10, Public schools, New Castle, Pa. 1910–15, Hackley School, Tarrytown, N. Y.
Present position—1915 to date: Student Mass. Inst. of Technology.

Victor Samoyloff, Brighton, Mass.
Proposed by Charles E. Locke, Edward E. Bugbee, Carle R. Hayward.
Born 1878, Russia. 1898, Gymnasium Kursk, Russia. 1898–1909, Mining Institute, Petrograd.
Present position—Student, Mass. Inst. of Technology.

Change of Status—Junior Associate to Member

Johannes Cornelissen, Arequipa, Peru.
Proposed by B. B. Thayer, William Braden, R. M. Raymond, E. J. Hall, William Campbell.
Born 1891, Amsterdam, Holland. 1897–1909, Grammar and high schools, Amsterdam, Holland. 1910–14, School of Mines, Columbia Univ., E. M. 1914, Assisted Mr. R. V. Norris, examination work. 1914–15, Timberman, drill runner and shiftboss, New Jersey Zinc Co., Franklin, N. J., 1916, Prospecting, Colombia, S. A.
Present position—1917 to date: Scout, geol. and examination work, The Andes Exploration Co.

BIOGRAPHICAL NOTICES

AMOS PEASLEE BROWN

Amos P. Brown, Professor of Geology and Mineralogy at the University of Pennsylvania, and a member of the Institute since 1888, died at Atlantic City, Oct. 9, 1917. An extended biography, by his classmate and lifelong associate, Witmer Stone, was published in the *Proceedings* of the American Philosophical Society, Vol. 57 (1918), from which the following brief extracts have been taken. For want of space, we must omit reference to Professor Brown's extensive and valuable work on botany, zoology, paleontology, and physiology, to the latter of which sciences he applied the methods of microscopic crystallography with striking success.

Amos Peaslee Brown was born in Germantown, Philadelphia, on Dec. 3, 1864, the son of Amos Peaslee and Frances Brown, and the fourth child of a family of seven sons and two daughters. His earliest education was received at a small private school, but in the autumn of 1877 he entered the Germantown Academy. Deciding to take a scientific course in college he did not study Greek, and dropped Latin in his last years at school. He was thus able to graduate in June, 1882, entering the University of Pennsylvania the following autumn.

He took the Towne scientific course, specializing in mining engineering after the sophomore year. He studied mineralogy under Prof. George A. Koenig, chemistry under Prof. Frederick A. Genth, physics under Prof. George F. Barker, astronomy under Prof. E. Otis Kendall, civil engineering under Prof. Lewis M. Haupt, mathematics under Prof. Henry W. Spangler and botany under Prof. Joseph T. Rothrock. He graduated in June, 1886, receiving the degree of B. S., and was chosen to deliver the bachelor's oration at the commencement at the old Academy of Music. He remained at the University another year, taking the post-graduate course in mining, and received the degree of E. M. in June, 1887.

Soon after graduation, Brown secured a position as aide on the Second Geological Survey of Pennsylvania, under Ashburner, his first work consisting in the compilation of data respecting the coal-mining operations of the State. This occupied a year, mostly in the field, followed by office work in Pittsburgh.

Finishing his work in the bituminous region in June, 1888, Brown returned to Philadelphia and accepted a position under Mr. Benjamin Smith Lyman, who had undertaken a survey of the New Boston and Morea coal lands in Schuylkill County, near Pottsville. The survey was a private enterprise, but the map was afterward published by the State Geological Survey. This work kept Brown in the field until late in the autumn, while the actual drawing of the map was done in Philadelphia in the winter. In the following spring Mr. Lyman engaged in a survey and report on the "New Red" formation of Bucks and Montgomery Counties, in which Brown again acted as his assistant and prepared an account of the igneous rocks of the district, which accompanies Mr. Lyman's report. His name appears on both the Bucks County map and that of the Morea anthracite district. In the early autumn of 1889, before the Bucks County survey was completed, Brown left Mr. Lyman to accept a position as instructor in mining at the University of Pennsylvania, under his old professor, Dr. Koenig, and here he remained for practically the rest of his life. In 1890 he was instructor in mining and metallurgy; in 1892 professor of mineralogy and geology in the auxiliary department of medicine, which he held until the abolishment of the department in 1898. On March 5, 1895, he became assistant professor of mineralogy and geology in the college faculty, and full professor in the spring of 1903, a position which he continued to hold until the spring of 1917, when he was forced to resign on account of failing health. From the autumn of 1892, after Dr. Koenig's retirement from the University, Brown took over the entire direction of the department, teaching in all branches of the subject—mineralogy, geology, lithology, crystallography, mining, and metallurgy. Soon after his return to the university he began studying for the degree of Doctor of Philosophy, which was conferred upon him on June 16, 1893.

During the time of his first activity at the Academy of Natural Sciences, he became closely associated with Edward D. Cope, who was then professor of mineralogy and geology—later of zoology and comparative anatomy—at the University of Pennsylvania, and who thoroughly appreciated Brown's ability and broad knowledge. In

the summer of 1893, having arranged for an exploration of some of the fossil beds of the West in the interests of the Academy, Cope invited Brown to become his associate on the trip, an invitation which he eagerly accepted. Their explorations began at Bismarck, N. D., on July 10, and covered parts of both North and South Dakota, the Cimmaron River District of Oklahoma, the northeastern border of the Staked Plains of Texas and portions of Kansas, coming to a close on September 4, at Galena, Mo. The results of the reconnaissance are set forth in a paper by Cope in the *Proceedings* of the Academy.[1]

In August, 1902, he made a cruise along the Labrador coast, and camped for several weeks at Dove Point, at the head of Sandwich Bay. He devoted his attention mainly to geological problems, and to a study of the general geology and topography of the country. In 1904, he made geological studies for certain mining properties in the central Rocky Mountains, and in succeeding years made similar trips to Utah, Nevada, and Oregon.

Up to 1900, Brown had published comparatively little. In 1888, he wrote an admirable account of the "Modes of Occurrence of Pyrite in Bituminous Coal,"[2] as part of his work with the State Survey. In this he recognized five forms of occurrence and traced the origin of the pyrite to the iron content of decomposing plants affected by the sulphur from gypsum or hydrogen sulphide. Nodular pyrite he suggested was formed from fish remains in the same way; while attention is called to the present-day formation of pyrite in the scum seen on stagnant pools. In 1894, he published "A Comparative Study of the Chemical Behavior of Pyrite and Marcasite,"[3] which was his thesis for the degree of Doctor of Philosophy. This is distinctly a piece of chemical research, dealing with the relative oxidation of sulphur in these two mineral forms of FeS_2, by various solutions, as well as the solubility of the iron in various acids. He published the first definite account of the crystallization of molybdenite in 1896[4] and in 1898 a scholarly account[5] of "Jade and Other Green Stones." There were several short notes on microscopical[6] and geological[7] subjects published in 1896 and 1897 and the notes in Lyman's report[8] and in Cope's paper[9] already referred to. In 1901 he also brought out a new edition of Erni's well-known textbook, "Mineralogy Simplified,"[10] which was used by his classes at the University. Part II of this work was entirely rewritten, while Part III, on "Physical Determinative Mineralogy," was wholly original and reflects Brown's views on the importance of sight identification of minerals.

Brown took a trip to Jamaica in February, 1910, his first experience in the tropics, and became so much interested in the natural history of the island that he returned for another visit in April, passing on this time to Panama, where he studied the geological formations exposed in the canal cuts and discovered some interesting beds of fossils from which he made valuable collections. The study of these upon his return to Philadelphia showed them to be of such importance that he was led to make still another trip in August for the purpose of securing additional material.

During the period just described, two mineralogical publications were issued in which Brown's name appears as joint author. One of these, in the preparation of which he was associated with Dr. Persifor Frazer, consisted of a series of tables for the determination of minerals by physical properties,[11] while the other, in which Dr. Frederick Ehrenfelt was his associate, was a report on the minerals of Pennsylvania[12] published by the Topographical and Geological Survey of the State in 1913.

---

[1] "Observations on the Geology of Adjacent Parts of Oklahoma and N. W. Texas," *Proc.* Acad. Nat. Sci. Phila., 1894, pp. 63–68.

[2] *Trans.* A. I. M. E., 1888, **16**, pp. 539–546.

[3] *Proc.* Amer. Philos. Soc., XXXIII, 1894, 225–243.

[4] *Proc.* Acad. Nat. Sci. Phila., 1896, pp. 210–211.

[5] *Bull.* Mus. Sci. and Art, Univ. of Penn., I, No. 3, pp. 140–145, April, 1898.

[6] "Bog Moss Leaves," *Amer. Monthly Microscop. Jour.*, XVIII, 1897, 232.

[7] "Red Color of Certain Formations," *Amer. Geologist*, XVII, 1896, p. 262. "Section of Chalcedony," *Amer. Monthly Microscop. Jour.*, XVIII, 1897, p. 235.

[8] Report on the New Red of Bucks and Montgomery Counties. Final Rept. Penn. State Geol. Survey (1895), Vol. III, Pt. II, pp. 2589–2638.

[9] *Proc.*, Academy of Natural Science, 1894, pp. 63–68.

[10] "Mineralogy Simplified." Third edition (1901), Philadelphia, Henry Carey Baird & Co., pp. i–xxvii + 1–383.

[11] "Tables for the Determination of Minerals by Physical Properties," Philadelphia, J. B. Lippincott & Co., 1910, pp. i–xiii, I, 1–125.

[12] "Minerals of Pennsylvania," Topog. and Geolog. Survey of Penna., Report No. 9, pp. 1–160, 1913.

In the summer of 1913 Brown made another trip to the tropics, touching at Georgetown, British Guiana, and spending some time on the island of Antigua. Here he made a representative collection of fossils and on his return published a comprehensive account of the geology of the island.[13]

Professor Brown's powers of observation were keen and his deductions remarkably accurate. He had well-defined opinions on scientific topics and, while not hesitating to express them, he was loath to force them upon others or to engage in argument or controversy, and in assuming without protest whatever tasks were allotted to him he often bore far more than his share of the burdens of life. His quiet unassuming manner attracted those with whom he came in contact, while he possessed none of the qualities that make enemies.

ROBERT BROWN CARNAHAN, JR.

Robert Brown Carnahan, Jr., Vice-President of the American Rolling Mill Co., Middletown, Ohio, died on June 22, 1918, at Middletown. He was born at Pittsburgh, Pa., Mar. 17, 1870.

Mr. Carnahan's active business career began with the Dewees-Woods Co., of McKeesport, Pa., with whom he became associated in 1891 upon graduating from the University of Pittsburgh. In 1899 he went with the Carnegie Steel Co. at its Homestead Works, where he was engaged in special research in connection with the development of the open-hearth furnace. When the American Rolling Mill Co. began operations in 1900, Mr. Carnahan became one of the first members of the working organization in the capacity of chief chemist and open-hearth superintendent. Mr. Carnahan was connected with the American Rolling Mill Co. until his death, holding the position of General Superintendent and later Vice-president in charge of research and metallurgical development work. It was under his direction that Armco iron was developed.

Mr. Carnahan was a man of most unusual talents and energy and through his study and development of metallurgical problems connected with the use of the open-hearth furnace in the iron and steel industry, became a scientist of international note. The results of his studies constitute a distinct contribution to the advancement of American and foreign metallurgy. Mr. Carnahan was granted the Degree of Doctor of Philosophy by the University of Pittsburgh in June, 1912. Though indomitable and untiring in his work, Mr. Carnahan's generous, kindly and optimistic spirit made him many warm friends here and abroad.

In addition to membership in the American Institute of Mining Engineers, he was also a member of the American Iron and Steel Institute, British Iron and Steel Institute, American Society for Testing Materials, University Club, Queen City Club and Business Men's Club of Cincinnati.

DAVID C. DODGE

David C. Dodge, one of the foremost railroad pioneers of Colorado, died at Denver, July 19, 1918, at the age of 81 years. He had been a member of the Institute since 1911.

Colonel Dodge was born in Shirley township, Mass., Nov. 17, 1837, and received his schooling at Lawrence academy, Groton, Mass.

He went to Denver in the early sixties and engaged in the general mercantile business with the Milo Smith company. He soon entered

---

[13] "Notes on the Geology of Antigua," *Proc.* Acad. Nat. Sci. Phila., 1913, pp. 584–616.

public life and served as city clerk and as a member of the board of public works of Denver.

He entered the railroad business in February, 1853, and began as chairman of the engineer corps of the Fox River Valley road in Illinois and Wisconsin and in the engineer corps of the Wisconsin Central Railroad. From March, 1856, to 1857, he was with the engineering department of the Chicago, Iowa & Nebraska road. From 1857, he began service as general freight and passenger agent and paymaster of the same road.

In 1864 he went to Chattanooga, Tenn., to serve in the commissary department of the United States army and later served in the quartermaster's department at Memphis. He was general agent of the Chicago & Northwestern railroad of Nevard, Iowa. From 1867 to 1870 he served as general agent of this road in Denver, helping to build the first lines into Denver at the same time.

The next year, when the Kansas Pacific was completed to Denver, he became general agent of that road. About this time he began to dream of a railroad running along the mountains with spurs into each of the canons. In this he was supported by Gen. W. J. Palmer, Gov. A. C. Hunt and R. F. Weitbrec. Then the Denver & Rio Grande was completed to Colorado Springs and Mr. Dodge became its first freight and ticket agent.

In 1880, he became general manager of the road. It was the acquaintance and close friendship between General Palmer and Colonel Dodge that meant greater things for Colorado from this time forward, for all of the great railroad building projects began at this time.

In 1885, Colonel Dodge was sent to Mexico to manage the affairs of the Mexican National Railway. He became its second vice-president under General Palmer in 1887. Then, as manager of the Rio Grande Western in Utah, Colonel Dodge built a standard-gauge road through to Salt Lake City. For the next 11 years he and General Palmer were building constantly. He was once receiver for the Moffat road and invested heavily in its reconstruction, pushing its rails, even during the panic of 1907, through to the coal fields in the Gore cañon.

His achievements were summed up by his friend, Andrew S. Hughes, traffic manager of the Denver & Rio Grande, as follows: "Colonel Dodge was at all times interested in upbuilding this State. As a railroad manager he stood pre-eminent, and also belonged to that fast diminishing band of pioneers that did so much toward the advancement of Colorado and the West generally. A strong man among able men, he will be sadly missed by the community at large."

JOHN DUER IRVING

John Duer Irving, who left his post as Professor of Economic Geology at the Sheffield Scientific School, New Haven, Conn., to join the Eleventh Regiment of Engineers shortly after the declaration of war, died in France, July 26, 1918, from an attack of pneumonia. Through the initiative of Mr. Benjamin B. Lawrence, a memorial service to Captain Irving was held at St. Paul's Chapel, Columbia University, on Sunday afternoon, August 4, which was attended by members of Captain Irving's family, and about four hundred of his friends from Columbia, Yale, the American Institute of Mining Engineers and the Association of the 11th Regiment of Engineers. Professor James F. Kemp delivered the memorial address,

and has prepared for the *Bulletin* the following account of Captain Irving's life, Professor Kemp and Captain Irving having been associated on the most intimate terms for a number of years.

The war has brought home to friends and kin in the western shores of the Atlantic many losses whose suddenness has the shock of a blow. Many more will follow, but none can leave a sharper sense of regret than

CAPTAIN JOHN DUER IRVING.

the news that the keen and productive mind; the inspiring teacher; the successful and considerate editor, the fine, true man and friend had all passed away when John Duer Irving made the final great gift to the service of his country, in the cause of decency and right. In the closing days of July, the cable brought the tidings that toward midnight on the twentieth of the month pneumonia had proved too great a tax upon one already worn by excessive labors.

John Duer Irving was born in Madison, Wis., August 18, 1874. His father, Roland Duer Irving, was at the time professor of geology, mineralogy and metallurgy in the State University of Wisconsin. Roland Irving, the father, had entered Columbia College in 1863, but trouble with his eyes compelled him to suspend his studies in the classical course in his sophomore year, and to replace study with some months of life and travel in England. Ultimately his eyes became stronger, and he entered the School of Mines, completing the course for the degree of Engineer of Mines in 1869, with the third class graduated. The class of eleven contained other future geologists. It numbered on its roll Henry Newton and Walter P. Jenney of the early survey of the Black Hills, where John, future son of Roland, was in the course of years to make his doctor's dissertation, and with its publication his really serious entrance into the profession.

Roland Irving was a favorite student of Professor J. S. Newberry, affectionately known to all of his students as "Uncle John," and after some experience in mining and smelting in Pennsylvania and New Jersey, joined the Ohio Survey under Dr. Newberry. The work in Ohio was largely performed during the vacations of the University of Wisconsin, to whose chair Roland Irving was called in 1870. Later, his residence in Wisconsin led to two events of prime importance in the history of American geology. He began the study of the Gogebic iron range and caught the clue to the origin and stratigraphy of the iron ores of all the Lake Superior ranges; and he later undertook the mapping and description of the copper-bearing rocks of the Lake Superior basin. The formative years of the son, John, were passed in a home where the father, Roland, was preparing the now famous monographs on these two subjects. Not alone did John's father work upon their preparation, but the skilful hand and fine sense of color of his mother were placing on paper the beautiful illustrations of the microscopic mineralogy of the copper-bearing rocks, and all in the very early days of microscopic rock study in America.

In John's fourteenth year, illness, preying on a constitution never over-strong, deprived him of his father, and left him the almost sacred duty of following in the footsteps and continuing the work of one interrupted at thirty-nine in mid-career. Mrs. Irving removed to the East among her kinsfolk and John was prepared for Columbia College to represent the fourth generation of his name upon the alumni rolls. His boyhood period passed and his college and university life began.

He entered in 1892 and took the prescribed courses of the time. The vacation of 1895, following his junior year, was passed with one of Professor Osborn's parties in searching for Tertiary vertebrates in the Browns Park beds of northeastern Utah. On the observations there obtained was based the first contribution of John Irving to geological literature. Following his senior year, he went with the writer to the Adirondacks and had a month or two of experience with old-time crystalline rocks in the mountains around Elizabethtown. In the vacation after his first year of graduate study a place was found for him in the field-party of Dr. Whitman Cross in the steep and rugged mountains of the San Juan region of southwestern Colorado.

About this time the writer made a visit to the northern Black Hills of South Dakota and became impressed with the extremely interesting problems presented by the local geology, which, as earlier stated, had been

covered by the pioneer work of Roland Irving's old classmates, Henry Newton and Walter P. Jenney. A large-scale map had been prepared by Professor Frank C. Smith and Dr. MacGillicuddy of the Dakota School of Mines, of Rapid City, and by the generous coöperation of these two friends, John Irving was suitably started upon his four months of field-work for his doctor's dissertation. With the completion and publication of his results and the taking of his doctor's degree, the second period of his life merged into the third—that of active work in the outside world.

Combined with a most creditable passing of the civil service examinations, his work in the Black Hills brought to its author an appointment in the ranks of the U. S. Geological Survey, and assignment to the party then undertaking the investigation of the mineral resources of this area. The study of the mines placed young Dr. Irving in close association with the most respected of American mining geologists, that fine, true, Nature's nobleman, Samuel Franklin Emmons, and in the end, made of John Irving, Dr. Emmons' closest helper. Years afterward, when Dr. Emmons passed away, leaving in fragmentary and uncompleted state the great new monograph on Leadville, it was John Irving who finished the manuscript and forwarded it to the Survey, ready for the printer.

Following the field experience in the Black Hills, John Irving was busied in association with F. L. Ransome in the Globe district of Arizona; with J. M. Boutwell in the Park City district of Utah; with W. H. Emmons in the Needle Mts. quadrangle of Colorado; and with Howland Bancroft at Lake City in the same state. He also did mapping of coal-bearing quadrangles in Indiana under M. L. Fuller, and in Pennsylvania, under M. R. Campbell. Most important of all, be became in time the right-hand man of Dr. Emmons in the revision of the Leadville monograph. While on the Survey and spending the winters in Washington, John Irving entered heartily into the life of the younger men, and was active in the so-called Association of Aspiring Assistants of the Survey; whose initials were a sort of caricature of the American Association for the Advancement of Science.

But the desire to teach, partly inherited, partly acquired, was very strong, too strong to be longer suppressed; and with its gratification in 1903 John Duer Irving took up after ripe preparation, the teacher's part of his career. The opportunity came to the writer to suggest to an old friend, Professor Wilbur C. Knight, of the University of Wyoming, one who might substitute for him during a year's leave of absence. The offer proved agreeable to Dr. Irving, and he undertook the work, retaining his connection with the Survey for the free time of the vacations. Some of the Survey work outlined above, was indeed done after he had begun to teach. In 1904 he was called to be assistant professor of geology at Lehigh University, and was promoted to the full chair in 1906. In 1907 he was called to be professor of economic geology at the Sheffield Scientific School of Yale, where he shared in developing the mining course made possible by the gift of the Hammond Laboratory. This professorship Dr. Irving held at the time of his death.

In 1905, while John Irving was at work at Lehigh University, the plan was developed of establishing a magazine which might be the special means of expression and record for the vigorous young school of American students of ore deposits and applied geology, which had then become a marked feature of our scientific life. We gathered a little band of pioneers,

willing to risk a part of their not over-abundant worldly possessions in the venture with no thought of return. John Irving was our choice for managing editor. To his untiring efforts, ably aided by the unselfish work of W. S. Bayley, as business manager, we chiefly owe the thirteen volumes of this most valuable and interesting journal, *Economic Geology*. As we turn its pages we see the subjects which appealed from time to time to its editor. His work in the mining districts emphasized the importance of ore shoots and localizations of values in veins, and he seeks to classify and systematize their causes. He is again impressed with the importance of a comprehensive study of special problems, wherever one particular case of them may be illustrated, as contrasted with the generally localized investigations carried on by one individual. The committee which has been studying for several years the problem of secondary enrichment under L. C. Graton, carries out exactly this idea. John Irving's extended Leadville experience, in the mines where S. F. Emmons first formulated the ideas of replacement of rock by ore, leads him to seek to establish criteria whereby replacement bodies may be identified. Thus as we turn the pages of the magazine we see how, year by year, an active and thoughtful mind was philosophically pondering, now this, now that important phase of his special branch of science.

And then, while in the full exercise of his many useful activities, rose above the horizon the dark cloud of the Robber Barons' war. He, as all of us, awoke to the growing conviction that the world in which we lived was not what we had thought it; that our ideals of government, our rules of openness, loyalty and truth in the relations of life, the very conditions of our existence were in danger and would need the supreme effort to defend them. In the spring and early summer of 1916, the writer knows from intimate talks that John Irving felt the danger menacing our country and others like it, from the growing threat of the worst features of mediævalism. Being unmarried, he believed that even though he was past forty years of age, it was his duty to go to Plattsburg and enter the officers' training camp. He took up the routine earnestly and seriously and wrote with great pride of his promotion to be a non-commissioned officer. When the camp closed he entered his name as one available for service, if conditions should call for him. In the spring of 1917 these conditions materialized. He took his officer's examinations, was appointed captain in the 11th Regiment of Engineers, and was granted leave of absence by the authorities of Yale. At first he expected to serve as topographic engineer, or as an interpreter of air-plane maps. He jestingly referred to himself as "skyographer." Actually he became recruiting officer for his regiment, in whose ranks are so many of the Institute's members. With them he sailed for France in July, 1917. Of his special field of work we know only what the censorship has permitted us to learn from his letters. He was early engaged in railway construction and worked just as long hours as anyone could in building the arteries of supply and nourishment of the Army. His duties last Fall we know brought him under shell-fire and he learned to keep his nerve amid these trying conditions. Like so many of our boys he writes jestingly of them, taking the dangers in the light-hearted way of our countrymen, as being all in the day's work.

Later, as tunneling and the exploding of mines beneath the enemy's works, and all sorts of excavation became so important, he was detailed

to the engineers' school at headquarters and was busy with a seemingly endless procession of classes to be instructed in the rudiments of mining engineering. His letters show that the calls were hard, exacting and exhausting. He speaks of never having worked so hard in all his life. Probably his vitality ran low and his powers of resistance and recuperation were exhausted. We only know that he returned to the front, became a victim of the so-called Spanish grippe, which, despite every effort on the part of the medical staff, developed into pneumonia, and that one more name was added to the Roll of Honor.

As we look back over this brief sketch of a busy and useful life, we see that it was filled to the very limit. Those of us who knew John Irving well know that the duties and calls were met faithfully and with a high sense of responsibility. Many of them were essentially unselfish. The magazine *Economic Geology* was a labor of love. The time of Professor Irving was never so valuable but that a student could command advice and guidance. The full strength and more of Captain Irving were given to his country. And yet we know that the calls often bore heavily on a physique none too robust. Although tall and broad-shouldered of stature, our friend had some delicacy of constitution which asserted itself at times of special stress and which gave warning that certain limits must not be passed.

Although I have written of his scientific work, I have not mentioned that many talks while we have been off on trips together revealed to me ambitions in literary expression and composition which were in keeping with the high traditions of his family, bound up, as they are, with one of the very first of our really great men of letters. Insistent calls prevented John Irving from realizing all that was in his mind; but the ambition certainly gave lucidity and clearness to his scientific writings.

It is, however, as friend that we like best to recall him, and in these respects we know well, that while his work lives after him, the fine sweet inspiration of his life will endure still longer. We live in the most trying times with which we have all been confronted for nearly three generations. Faith is called for, as almost never before. We must have the grim and unshaken holding on to calm belief in the triumph of right and in the subordination of cruelty and unbridled selfishness to the control of law and justice. A decent consideration for the rights of others and observance of these must not perish from the earth, nor must the rule of abominable materialism be permitted to exercise its sway over victims unable to protect themselves. For these high causes John Duer Irving gave his all. Useful and inspiring as he was in life, he rises to yet greater heights in his supreme sacrifice, and to us who yet remain he is a sermon whose moving appeal causes to sound aloud the deepest chords of our nature.

JAMES F. KEMP.

BIBLIOGRAPHY OF THE WORKS OF JOHN DUER IRVING

1896.—The Stratigraphical Relations of the Browns Park Beds of Utah. *Transactions*, New York Academy of Sciences (1896), **15**, 252–259.

1898.—Contact-Metamorphism of the Palisades Diabase. Abstract. *American Geologist* (1898), **21**, 398.

1899.—A Contribution to the Geology of the Northern Black Hills. *Annals*, New York Academy of Sciences (1899), **12**, 187–340.

Contact Phenomena of the Palisade Diabase (New Jersey). *School of Mines Quarterly* (1899), **20**, 213–223.

1901.—Some Recently Exploited Deposits of Wolframite in the Black Hills of South Dakota. *Trans.* A. I. M. E. (1901), **31**, 683–695.

1903.—Ore Deposits of the Northern Black Hills. *Mining and Scientific Press* (1903), **87**, 166–167, 187–188, 221–222.

1904.—Ore Deposits of the Northern Black Hills. *Bulletin* **225**, U. S. Geological Survey (1904), 123–140.

The Ore Deposits of the Northern Black Hills. *Mining Reporter* (1904), **50**, 430–431.

JOHN DUER IRVING AND S. F. EMMONS. Economic Resources of the Northern Black Hills. Part II. Mining Geology. *Professional Paper* **26**, U. S. Geological Survey (1904), 43–222.

1905.—JOHN DUER IRVING AND W. H. EMMONS. Economic Geology of the Needle Mountains Quadrangle (Colorado). *Geologic Atlas*, U. S. Geological Survey (1905), **131**.

Microscopic Structure and Origin of Certain Stylolithic Structures in Limestone. Abstract. *Annals*, New York Academy of Sciences (1905), **16**, 305–306. Same. *American Geologist* (1904), **33**, 266–267.

Ore Deposits in the Vicinity of Lake City, Colorado. *Bulletin* **260**, U. S. Geological Survey (1905), **260**, 78–84.

1905.—Ore Deposits of the Ouray District, Colorado. *Bulletin* **260**, U. S. Geological Survey (1905), 50–77.

University Training of Engineers in Economic Geology. *Economic Geology* (1905), **1**, 77–82.

1906.—Review of "The Geological Map of Illinois," by Stuart Weller (Ill. State Geol. Survey, *Bull.* No. 1). *Economic Geology* (1906), **8**, 816–818.

1907.—JOHN DUER IRVING, WHITMAN CROSS AND ERNEST HOWE. Description of the Ouray Quadrangle (Colorado). *Geologic Atlas*, U. S. Geological Survey (1907), **153**, 20 pp.

JOHN DUER IRVING AND S. F. EMMONS. The Downtown District of Leadville, Colorado. *Bulletin* **320**, U. S. Geological Survey (1907), 75 pp.

1908.—The Localization of Values or Occurrence of Shoots in Metalliferous Deposits. *Economic Geology* (1908), **3**, 143–154.

1910.—Special Problems and Their Study in Economic Geology. *Economic Geology* (1910), **5**, 670–677.

1911.—JOHN DUER IRVING AND HOWLAND BANCROFT: Geology and Ore Deposits near Lake City, Colorado. *Bulletin* **478**, U. S. Geological Survey (1911).

Replacement Ore-Bodies and the Criteria for Their Recognition. *Economic Geology* (1911), **6**, 527-561, 619–669.

JOHN DUER IRVING AND WALDEMAR LINDGREN. The Origin of the Rammelsberg Ore Deposit. *Economic Geology* (1911) ,**6**, 303-313.

1912.—Discussion on a Concise Method of Showing Ore Reserves. *Trans.* (1912), **43**, 714.

Geological Diagnosis (Editorial). *Economic Geology* (1912), **7**, 83–86.

Some Features of Replacement Ore Bodies and the Criteria by Which They May be Recognized. *Journal*, Canadian Mining Institute (1912), **14**, 395–471.

(Geological Field Methods. Editorial.) *Economic Geology* (1913), **8**, 64–65.

JOHN DUER IRVING, H. D. SMITH AND H. G. FERGUSON. A Selected List of the More Important Contributions to the Investigation of the Origin of Metalliferous Ore Deposits. In S. F. EMMONS' Volume on Ore Deposits. A. I. M. E. (1913), 837–846.

1913.—The Substructure of Geological Reports. *Economic Geology* (1913), **8**, 66–96.

1915.—Discussion on Recrystallization of Limestone at Igneous Contacts. *Trans.* (1915), **48**, 214.

Discussion on To What Extent is Chalcocite a Primary, and to What Extent a Secondary Mineral in Ore Deposits. *Trans.* A. I. M. E. (1915), **48**, 194.

1916.—Discussion on the Iron Deposits of Daiquiri, Cuba. *Trans.* A. I. M. E. (1916), **53**, 65.

Discussion on the Iron Ore Deposits of the Firmeza District, Cuba. *Trans.* A. I. M. E. (1917), **56**, 135.

1918.—Chapter on "Geological Data for Prospecting and Exploration," in *Mining Engineers' Handbook* (Peele), 392–408.

ANGUS R. MACKAY

Angus R. Mackay, manager of the Vulture mine, Yavapai County, Ariz., died suddenly at Oakland, Cal., June 29, 1918. He was the eldest son of the late Senator Robert Mackay, of Montreal. He graduated from the Massachusetts Institute of Technology in 1893, taking the course in mining engineering, and then spent some time studying in Germany. Returning from Europe, he became manager of the Horseshoe mine at Deadwood, S. D., and it was through his efforts that the property became a profitable one. Later he became engaged in engineering work at Niagara Falls, and in 1908 came to Arizona, where he was instrumental in reviving the old Vulture mine. He was manager of the property from 1908 to the time of his death.

Mr. Mackay became a member of the Institute in 1896, and was also a member of the American Society of Civil Engineers. His interests and activities were large and varied, and he was especially interested in developing the resources of Arizona. He had a large number of friends, who were shocked and saddened to learn of his death.

F. W. LIBBEY.

THOMAS MCNAIR RIGHTER

Thomas M. Righter died at Mt. Carmel, Pa., from paralytic stroke, on July 12, 1918. He became a member of the Institute in 1899.

Mr. Righter was born in Berwick, Columbia county, Pa., Jan. 12, 1847, the son of Doctor William W. and Jane (McNair) Righter. When he was a child the family moved to Mauch Chunk, and Thomas was educated in the public schools of that place. At the age of fifteen he left school and endeavored to enlist in the Federal Army, but was rejected because he was too young. However, he was given a position as railway mail clerk, taking the place of a man who entered the military service.

The late Judge John Leisenring, pioneer railroad builder, was attracted by the industry and the intelligence of the young man, and offered him a place on the engineer corps engaged in laying out the Jersey Central lines from Mauch Chunk to Wilkes-Barre. Later he became a mining engineer at Upper Lehigh. His great skill in mining matters soon become evident, and he was made superintendent of the Sandy Run Coal Co., operated by M. S. Kemerer & Co. In 1881 Mr. Righter and E. B. Leisenring purchased the interest of J. C. Hayden in the Montelius-Hayden colliery at Mount Carmel. Two years later Alfred Montelius died, when Mr. Righter and Mr. Leisenring became the owners of the old Montelius colliery, operating it under the name of Thomas M. Righter & Co. until it passed into the hands of the Lehigh Valley Coal Company.

Mr. Righter was one of the incorporators of the Mount Carmel Water Co. and was its President at the time of his death. He helped to found the Edison Electric Illuminating Co., and remained as one of its directors until recently, when the corporation passed from local control. Leading in the movement to organize the Union National Bank, he was made President of its Board of Directors, an office he held until his demise. He was a director of the Shamokin-Mount Carmel Transit Co. Associated with G. M. Smith, he helped to build the trolley road, and laid out the line extending from Centralia to Ashland.

Mr. Righter's activities extended all over Pennsylvania and into West Virginia. He was President and General Manager of the Oak Hill Coal Co., Duncott, Schuylkill county. He served on the directorate of the Midvalley Coal Co., operators of the collieries at Wilburton; and of the Mt. Jessup Coal Co., Scranton. Anthracite coal mining was given his closest attention and he was a recognized authority in that industry, but he invested heavily in bituminous mines, and was the President of the Jewel Ridge Coal Co. of Tazewell, West Virginia, and was the President of the Pocahontas Coal Corporation, owning 22,000 acres of valuable coal lands in West Virginia. He was also a director of the E. E. White Coal Co., of Glen White, West Virginia.

He served as director of the Whitehall Cement Manufacturing Co. of Cementon, Pa., and of the Clear Springs Water Co. of Catasauqua.

Devoted though he was to the many enterprises which he helped to form and guide, Mr. Righter was not too busy to take a leading part in church work, and he was a true Christian gentleman whose life was an inspiration to all who knew him.

For nine years he served the community as a member of the Board of Education, being President of the Board for eight of these years.

The State Hospital for Injured Persons at Fountain Springs took much of his valuable time, but it was given cheerfully and wholeheartedly. Appointed in 1889 by Governor Beaver as one of the first Trustees of that splendid institution, he was President of the Board at the time of his death.

STANDING COMMITTEES

Executive

SIDNEY J. JENNINGS, *Chairman*

GEORGE D. BARRON
EDWIN LUDLOW
J. E. JOHNSON, JR.
ROBERT M. RAYMOND

Membership

KARL EILERS, *Chairman*

LEWIS W. FRANCIS
LOUIS D. HUNTOON
J. E. JOHNSON, JR.
ARTHUR L. WALKER

Finance

GEORGE D. BARRON, *Chairman*

CHARLES F. RAND
BENJAMIN B. THAYER

Library

E. GYBBON SPILSBURY,[1] *Chairman*

ALEX C. HUMPHREYS[3]
J. H. JANEWAY[4]
GEORGE C. STONE[2]
BRADLEY STOUGHTON

Papers and Publications

BRADLEY STOUGHTON, *Chairman*

EXECUTIVE COMMITTEE

PERCY E. BARBOUR
WILLIAM A. COWAN
H. C. PARMELEE
THOMAS T. READ
JOSEPH W. RICHARDS
GEORGE C. STONE
SAMUEL A. TAYLOR

J. L. W. BIRKINBINE
WILLIAM H. BLAUVELT
H. A. BRASSERT
WILLIAM CAMPBELL
R. M. CATLIN
ALLAN J. CLARK
FREDERICK G. COTTRELL
KARL EILERS
NATHANIEL H. EMMONS
JOHN W. FINCH
CHARLES H. FULTON
F. LYNWOOD GARRISON
ROBERT C. GEMMELL
H. W. GILLETT
CHARLES W. GOODALE
HARRY A. GUESS
R. DAWSON HALL
PHILIP W. HENRY
HEINRICH O. HOFMAN
WALTER E. HOPPER
HENRY M. HOWE
LOUIS D. HUNTOON
J. E. JOHNSON, JR.
WILLIAM KELLY
JAMES F. KEMP
CHARLES K. LEITH
ANTHONY F. LUCAS
EDWARD P. MATHEWSON
HERBERT A. MEGRAW
PAUL D. MERICA
RICHARD MOLDENKE
SEELEY W. MUDD
R. V. NORRIS
EDWARD W. PARKER
NATHANIEL K. B. PATCH
R. M. RAYMOND
ROSSITER W. RAYMOND
ROBERT H. RICHARDS
L. D. RICKETTS
HEINRICH RIES
RENO H. SALES
ALBERT SAUVEUR
HENRY L. SMYTH
A. A. STEVENSON
RALPH H. SWEETSER
GEORGE D. VAN ARSDALE
ARTHUR L. WALKER
ROLLA B. WATSON
HORACE V. WINCHELL
FREDERICK W. WOOD
DWIGHT E. WOODBRIDGE

Nominations

R. V. NORRIS, *Chairman*

WALTER H. ALDRIDGE
WALTER DOUGLAS
D. W. BRUNTON
C. H. MACDOWELL
ALLEN H. ROGERS

EXECUTIVE COMMITTEES OF LOCAL SECTIONS

New York

Meets first Wednesday after first Tuesday of each month.

ALLEN H. ROGERS, *Chairman*
H. C. PARMELEE, *Vice-chairman*
FOREST RUTHERFORD, *Vice-chairman*
W. S. DICKSON, *Secretary*, 71 Broadway, New York, N. Y.
J. E. JOHNSON, JR.
F. T. RUBIDGE
P. G. SPILSBURY

Boston

Meets first Monday of each winter month.

ALFRED C. LANE, *Chairman*
G. A. PACKARD, *Vice-chairman*
E. E. BUGBEE, *Secretary-Treasurer*, Mass. Inst. of Technology, Cambridge, Mass.
R. L. AGASSIZ
FRED W. DENTON

Columbia

Holds four sessions during year. Annual meeting in September or October.

S. S. FOWLER, *Chairman*
J. C. HAAS, *Vice-chairman*
LYNDON K. ARMSTRONG, *Secretary-Treasurer*, 720 Peyton Bldg., Spokane, Wash.
W. H. LINNEY
J. F. McCARTHY

---

[1] Until Feb., 1919. [2] Until Feb., 1920 [3] Until Feb., 1921. [4] Until Feb., 1922.

Puget Sound

Meets second Saturday of each month.

HENRY LANDES, *Chairman* GEORGE E. ROCKEFELLER, *Vice-chairman*
PERCY E. WRIGHT, *Secretary-Treasurer*, 2012 L. C. Smith Bldg., Seattle, Wash.
SIMON H. ASH CHARLES SIMENSTAD

Southern California

RALPH ARNOLD, *Chairman* WILLIAM F. STAUNTON, *Vice-chairman*
ALVIN B. CARPENTER, *Secretary-Treasurer*, 530 Citizens National Bank Bldg., Los Angeles, Cal.
A. B. W. HODGES LESLIE C. MOTT
C. COLCOCK JONES JAMES W. NEILL

Colorado

CHARLES M. MACNEILL, *Chairman* GEORGE M. TAYLOR, *Vice-chairman*
FRED CARROLL, *Secretary-Treasurer*, State Capitol, Denver, Colo.
W. W. CASE H. E. COLLBRAN

Montana

N. B. BRALY, *Chairman* B. H. DUNSHEE, *Vice-chairman*
E. B. YOUNG, *Secretary-Treasurer*, 526 Hennesy Building, Butte, Mont.
F. W. BACORN C. D. DEMOND

San Francisco

Meets second Tuesday of each month.

A. C. LAWSON, *Chairman* ROY H. ELLIOTT, *Vice-chairman*
W. H. SHOCKLEY, *Secretary-Treasurer*, 959 Waverley St., Palo Alto, Cal.
T. A. RICKARD C. F. TOLMAN, JR

Pennsylvania Anthracite

R. V. NORRIS, *Chairman*
CHARLES F. HUBER, *Vice-chairman* EDWIN LUDLOW, *Vice-chairman*
W. J. RICHARDS, *Vice-chairman* ARTHUR H. STORRS, *Vice-chairman*
PAUL STERLING, *Secretary-Treasurer*, Lehigh Valley Coal Co., Wilkes-Barre, Pa.
DOUGLAS BUNTING W. W. INGLIS HENRY W. MONTZ
JOHN M. HUMPHREY EDWARD E. KAERCHER ROBERT A. QUIN

St. Louis

EUGENE McAULIFFE, *Chairman* J. N. HOUSER, *Vice-chairman*
VICTOR RAKOWSKY, *Vice-chairman* H. G. WASHBURN, *Vice-chairman*
WALTER E. McCOURT, *Secretary-Treasurer*, Washington Univ., St. Louis, Mo.
H. A. BUEHLER G. H. COX L. C. GLENN
E. A. HOLBROOK W. E. NEWNAM

Chicago

CHARLES H. MACDOWELL, *Chairman* LUTHER V. RICE, *Vice-chairman*
HENRY W. NICHOLS, *Secretary-Treasurer*, Field Museum of Natural History, Chicago, Ill.
ALEXANDER K. HAMILTON G. P. HULST
HENRY P. HOWLAND FREDERICK T. SNYDER

Utah

WILLIAM WRAITH, *Chairman* CECIL FITCH, *Vice-chairman*
F. G. MOSES *Secretary-Treasurer*, University of Utah, Salt Lake City, Utah.
ERNEST GAYFORD E. R. ZALINSKI

Arizona

P. G. BECKETT, *Chairman*
NORMAN CARMICHAEL, *1st Vice-chairman* J. C. GREENWAY, *2d Vice-chairman*
H. L. NORTON, *Secretary-Treasurer*, Globe, Ariz.
L. S. CATES F. W. MACLENNAN
L. O. HOWARD R. E. TALLY

Nevada

R. E. H. POMEROY, *Chairman* J. C. JONES, *Vice-chairman*
HENRY M. RIVES, *Secretary-Treasurer*, 210 Reno National Bank Bldg., Reno, Nev.
W. H. BLACKBURN FREDERICK BRADSHAW C. B. LAKENAN
EMMET D. BOYLE J. W. HUTCHINSON WHITMAN SYMMES
JOHN G. KIRCHEN

Mexico

(Instituto Mexicano de Minas y Metalurgia)

VICTOR M. BRASCHI, *Chairman*, Committee on Organization

Tulsa

ALF. G. HEGGEM, *Chairman* ALEXANDER DEUSSEN, *Vice-chairman*
CHARLES H. TAYLOR, *Vice-chairman*
M. M. VALERIUS, *Junior Vice-chairman* ERASMUS HAWORTH, *Vice-chairman*
JAMES H. GARDNER, *Secretary-Treasurer*, Tulsa, Okla.
IRVING PERRINE J. J. RUTLEDGE S. H. WORRELL

Washington, D. C.

HERBERT C. HOOVER, *Chairman*

H. FOSTER BAIN, *Vice-chairman* DAVID WHITE, *Vice-chairman*

HARVEY S. MUDD, *Secretary-Treasurer*, Room 2114, Dept. of Interior Bldg.

J. F. CALLBREATH HENNEN JENNINGS E. W. PARKER T. T. READ

COMMITTEE ON JUNIOR MEMBERS AND AFFILIATED STUDENT SOCIETIES

CHARLES H. FULTON, *Chairman*

Vice-chairmen

EDWIN C. HOLDEN
FREDERICK W. SPERR
GEORGE J. YOUNG

WALTER R. CRANE, *Secretary*, Pennsylvania State College, State College, Pa.

LUTHER W. BAHNEY
DARSIE C. BARD
ROBERT H. BRADFORD
SAMUEL W. BEYER
GUY H. COX
JOSEPH DANIELS
NOAH F. DRAKE
FRANK W. DURKEE
HOWARD ECKFELDT
DAVID M. FOLSOM
R. R. GOODRICH
CHARLES E. LOCKE
JAMES F. McCLELLAND
HARRY B. MELLER
WALTER S. MORLEY
HENRY S. MUNROE
CHARLES J. NORWOOD
H. C. PARMELEE
GEORGE S. RAYMER
HEINRICH RIES
HENRY L. SMYTH
HARRY H. STOEK
FRANCIS A. THOMSON
CLINTON M. YOUNG

COMMITTEE ON INCREASE OF MEMBERSHIP

J. V. N. DORR, *Chairman*

FOREST RUTHERFORD, *First Vice-chairman*

H. C. PARMELEE, *Secretary, Met. & Chem. Eng.*, 10th Ave. & 36th St., New York, N. Y.

Vice-chairmen

L. K. ARMSTRONG
C. H. BENEDICT
ELI T. CONNER
DORSEY HAGER
G. P. HULST
P. M. McHUGH
H. L. WILLIAMS
DWIGHT E. WOODBRIDGE
R. B. WOODWORTH

Committee

FRANK L. ANTISELL
C. E. ARNOLD
FRANKLIN BACHE
D. C. BARD
LOUIS V. BENDER
SAMUEL W. BEYER
NORMAN B. BRALY
G. S. BROOKS
FRANK BULKLEY
FRED CARROLL
THOMAS H. CLAGETT
G. M. COLVOCORESSES
ARTHUR CROWFOOT
H. W. DU BOIS
J. A. EDE
L. V. EMANUEL
NEWTON W. EMMENS
J. N. ESSELSTYN
ERNEST GAYFORD
H. W. HARDINGE
ENOCH HENDERSON
HERBERT B. HENEGAR
FRANK R. HEWITT
JOSEPH T. HILLES
T. A. JANNEY
ZAY JEFFRIES
FRANK G. JEWETT
ARTHUR G. JOHNSON
F. F. JORGENSEN
C. B. LAKENAN
LEONARD LARSON
E. T. LEDNUM
CHARLES LEGRAND
EUGENE McAULIFFE
ROBERT McCART, Jr.
JOHN H. McCHRYSTAL
W. E. McCOURT
V. H. McNUTT
T. W. MATHER
E. P. MATHEWSON
T. POOLE MAYNARD
H. W. MORSE
HENRY W. NICHOLS
C. C. O'HARRA
FRANK H. PROBERT
JOSEPH W. RICHARDS
W. W. ROSE
FRANK L. SIZER
LEWIS STOCKETT
WALTER G. SWART
ARTHUR M. SWARTLEY
ARTHUR F. TAGGART
JOHN C. TAYLOR
WILLIAM D. WALTMAN
JESSE B. WARRINER
E. R. WASH
W. Y. WESTERVELT
F. R. WICKES

INSTITUTE REPRESENTATIVES

United Engineering Society Trustees

CHARLES F. RAND[2] W. L. SAUNDERS[1] BENJAMIN B. THAYER[3]

Engineering Foundation

R. M. RAYMOND[1] J. W. RICHARDS BENJAMIN B. THAYER[3]

Library Board, United Engineering Society

ALEX C. HUMPHREYS[3] E. GYBBON SPILSBURY[1]
J. H. JANEWAY[4] BRADLEY STOUGHTON GEORGE C. STONE[2]

John Fritz Medal Board of Award

C. R. CORNING[3] E. GYBBON SPILSBURY[4]
CHARLES F. RAND[1] BENJAMIN B. THAYER[2]

Engineering Council

J. PARKE CHANNING[3] B. B. LAWRENCE[1]
S. J. JENNINGS[1] P. N. MOORE[2] EDWIN LUDLOW[2]

American Association for the Advancement of Science

WALDEMAR LINDGREN JOSEPH B. TYRRELL

Committee on Standardization of Graphical Methods

JUDD STEWART

Joint Committee on War Minerals

WILLIAM Y. WESTERVELT

Committee on Mining Law Revision

JAMES R. FINLAY HENNEN JENNINGS
D. C. JACKLING EDMUND B. KIRBY C. F. KELLEY

National Research Council

P. N. MOORE

Naval Consulting Board

Members

WILLIAM L. SAUNDERS BENJAMIN B. THAYER

Associate Members

STEPHEN O. ANDROS
E. J. BABCOCK
H. R. BATCHELLER
PHILIP R. BRADLEY
J. L. BRUCE
D. W. BRUNTON
ALLAN J. CLARK
F. K. COPELAND
B. F. CRESSON, JR.
ROBERT N. DICKMAN
M. M. DUNCAN
T. C. DU PONT
STANLY A. EASTON
W. E. C. EUSTIS
J. R. FORDYCE
FRANK B. GEARHART
J. C. GREENWAY
LAFAYETTE HANCHETT
C. B. HOLLIS
GEORGE P. HULST
FRANK U. HUMBERT
HENNEN JENNINGS
S. W. McCALLIE
A. J. McQUATTERS
C. W. MERRILL
P. N. MOORE
F. W. O'NEIL
WALTER T. PAGE
W. H. PEIRCE
JOSEPH H. PRATT
H. V. WINCHELL
J. C. RALSTON
CHARLES F. RAND
FRANK D. RASH
R. H. RICHARDS
C. S. ROBINSON
WALTER M. SAUNDERS
E. A. SAYRE
H. L. SCAIFE
A. M. SWARTLEY
PRIESTLEY TOULMIN
W. E. TRENT
M. M. VALERIUS
W. D. WALTMAN
I. C. WHITE
ELI WHITNEY

Committee on Engineering Education

JOHN HAYS HAMMOND HENRY MARION HOWE

Conference Committee on Proposed Adoption of Metric System

GEORGE F. KUNZ JOSEPH W. RICHARDS

Joseph A. Holmes Safety Association

HENNEN JENNINGS

Joint Conference Committee on American Engineering Standards

J. W. RICHARDS F. F. COLCORD ARTHUR L. WALKER

Joint Committee on Water Power Development

H. HOBART PORTER

Washington Medal Commission of Award

ROBERT W. HUNT[2] CHARLES H. MACDOWELL[1]

---

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921. [4] Until Feb., 1922.

Pan-American Engineering Committee

WALTER H. ALDRIDGE
FREDERICK K. COPELAND
JOSEPH W. RICHARDS
W. H. LEONARD
P. N. MOORE

Committee on Military Engineering of New York

J. PARKE CHANNING
ARTHUR S. DWIGHT
ALEX C. HUMPHREYS
CHARLES F. RAND
L. D. RICKETTS
WILLIAM L. SAUNDERS
BRADLEY STOUGHTON
WILLIAM H. WILEY

COMMITTEE ADVISORY TO THE U. S. BUREAU OF MINES

ARTHUR F. L. BELL
HENNEN JENNINGS
ALBERT R. LEDOUX
E. W. PARKER
L. D. RICKETTS

Electricity in Mining
WILLIAM KELLY
THOMAS H. LEGGETT
SAMUEL A. TAYLOR

Mine Explosions
H. M. CHANCE
FRANK HAAS
CARL SCHOLZ

Mine Subsidence
JAMES F. KEMP
R. V. NORRIS
CHARLES K. LEITH

COMMITTEE ADVISORY TO THE U. S. BUREAU OF STANDARDS

Copper: F. L. ANTISELL
Lead: ARTHUR S. DWIGHT
Nickel: JOHN F. THOMPSON
Aluminum: JOSEPH W. RICHARDS
Zinc: GEORGE C. STONE

COMMITTEE ADVISORY TO THE U. S. TARIFF COMMISSION

Ferrous Metals
J. E. JOHNSON, JR.
H. D. HIBBARD
RICHARD PETERS, JR.

Non-ferrous Metals
HERMAN GARLICHS
F. LYNWOOD GARRISON
FOREST RUTHERFORD

WAR MINERALS COMMITTEE

WILLIAM YOUNG WESTERVELT, *Chairman*,
Representing A. I. M. E., and M. and M. Soc. of Am.
ALFRED G. WHITE, *Secretary*,
Representing U. S. Bureau of Mines
W. O. HOTCHKISS,
Representing Association of American State Geologists
DAVID WHITE,
Representing U. S. Geological Survey
HARVEY S. MUDD, *Asst. Secretary*

Associate Members from the A. I. M. E.

H. A. BUEHLER
FRED CARROLL
N. F. DRAKE
R. D. GEORGE
E. A. HOLBROOK
EDWIN LUDLOW
S. W. McCALLIE
WILLET G. MILLER
EDMUND NEWTON
H. L. NORTON
WILLIAM C. PHALEN
T. A. RICKARD
CHARLES SIMENSTAD
H. H. STOEK
JOSEPH H. TAYLOR
ARTHUR L. WALKER
THOMAS L. WATSON
E. B. YOUNG

TECHNICAL COMMITTEES

Iron and Steel

JOSEPH W. RICHARDS, *Chairman*, Lehigh Univ., So. Bethlehem, Pa.
J. E. JOHNSON, JR., *Vice-chairman*

SUB-COMMITTEES

IRON ORE

DWIGHT E. WOODBRIDGE, *Chairman*

ERNEST F. BURCHARD
WILLIAM KELLY
CHARLES F. RAND

BLAST FURNACES

H. A. BRASSERT, *Chairman*

WILLIAM H. BLAUVELT
AMBROSE N. DIEHL
RICHARD V. McKAY
JAMES GAYLEY

STEEL WORKS

HENRY D. HIBBARD, *Chairman*

GUILLIAEM AERTSEN
FRANK D. CARNEY
C. F. W. RYS
J. S. UNGER
WILLIAM R. WALKER

MECHANICAL TREATMENT

A. A. STEVENSON, *Chairman*

CHARLES A. BUCK
ROBERT W. HUNT
GEORGE MESTA
FREDERICK W. WOOD

FOUNDRY

RICHARD MOLDENKE, *Chairman*

JOHN H. HALL
ENRIQUE TOUCEDA

CHEMISTRY, PHYSICS, AND METALLOGRAPHY

HERBERT M. BOYLSTON, *Chairman*

WILLIAM CAMPBELL
HENRY M. HOWE
JOHN A. MATHEWS
E. GYBBON SPILSBURY
ALBERT SAUVEUR
LEONARD WALDO
WILLIAM R. WEBSTER

Petroleum and Gas

ANTHONY F. LUCAS, *Chairman*
MARK L. REQUA, *First Vice-chairman*
ISAAC N. KNAPP, *Secretary*

RALPH ARNOLD, *Vice-chairman*
WILLIAM N. BEST, *Vice-chairman*
EDWIN T. DUMBLE, *Vice-chairman*
JAMES F. KEMP, *Vice-chairman*
LEONARD WALDO, *Vice-chairman*
DAVID WHITE, *Vice-chairman*
I. C. WHITE, *Vice-chairman*

ARTHUR F. L. BELL
FREDERICK G. CLAPP
EUGENE COSTE
DAVID T. DAY
ALEXANDER DEUSSEN
JOHN R. EDWARDS
JAMES H. GARDNER
DORSEY HAGER
ALFRED G. HEGGEM
L. L. HUTCHISON
EZEQUIEL ORDONEZ
M. M. VALERIUS
CHESTER W. WASHBURNE
HERBERT A. WHEELER
W. E. WRATHER

Coal and Coke

SAMUEL A. TAYLOR, *Chairman*

EDWIN LUDLOW, *Vice-chairman*
FREDERICK W. C. WHYTE, *Vice-chairman*
W. J. RICHARDS, *Vice-chairman*
H. H. STOEK, *Vice-chairman*

WILLIAM E. FOHL, *Secretary*, Farmers' Bank Bldg., Pittsburgh, Pa.

S. B. BELDEN
WILLIAM H. BLAUVELT
H. M. CHANCE
THOMAS H. CLAGETT
ELI T. CONNER
JAMES S. CUNNINGHAM
E. V. D'INVILLIERS
W. W. DUFFIELD
HOWARD N. EAVENSON
CHARLES ENZIAN
WILLIAM A. FORBES
WILLIAM H. GRADY
FRANK HAAS
R. DAWSON HALL
FRANK ALBERT HILL
CHARLES F. HUBER
JAMES ELLWOOD JONES
CHARLES E. KREBS
GEORGE J. KREBS
A. C. LEISENRING
SPENCER R. LOGAN
EUGENE McAULIFFE
CHARLES T. MALCOLMSON
FRANK A. MANLEY
R. V. NORRIS
CHARLES J. NORWOOD
FRANK A. RAY
THOMAS H. O'BRIEN
GEORGE S. RICE
JOHN J. RUTLEDGE
CARL SCHOLZ
JOHN ROY SHARP
T. W. SPRAGUE
ARTHUR H. STORRS
ISRAEL C. WHITE
WILLIAM G. WILKINS
LEWIS L. WILLARD
CLINTON M. YOUNG

Precious and Base Metals

CHARLES W. GOODALE, *Chairman*
ARTHUR L. WALKEAR, *Vice-chairman* ROBERT C. GEMMELL, *Vice-chairman*
DARSIE C. BARD, *Secretary*, Montana State School of Mines, Butte, Mont.

SUB-COMMITTEES

COPPER

EDWARD P. MATHEWSON, *Chairman*

LAWRENCE ADDICKS
W. LAWRENCE AUSTIN
JOHN C. GREENWAY
LAFAYETTE HANCHETT
L. OGILVIE HOWARD
FREDERICK LAIST
C. B. LAKENAN
GEORGE W. METCALFE
L. D. RICKETTS
FOREST RUTHERFORD
GEORGE D. VAN ARSDALE
ARTHUR L. WALKER
ARCHER E. WHEELER
ALBERT E. WIGGIN

GOLD AND SILVER

F. LYNWOOD GARRISON, *Chairman*

F. L. BOSQUI
PHILIP R. BRADLEY
CHARLES BUTTERS
ROBERT C. CANBY
ALLAN J. CLARK
GEORGE H. CLEVENGER
HARRY S. DENNY
JOHN V. N. DORR
CHARLES W. MERRILL
WILLET G. MILLER
CHARLES H. MUNRO
R. M. RAYMOND
WHITMAN SYMMES

LEAD

HEINRICH O. HOFMAN, *Chairman*

C. J. ADAMI
LEONARD S. AUSTIN
WILLIAM BRADEN
ARTHUR S. DWIGHT
KARL EILERS
HERMAN GARLICHS
ERNEST A. HERSAM
G. P. HULST
SIDNEY J. JENNINGS
FRANK M. SMITH
WILLIAM A. SMITH
FREDERIC R. WEEKES
RUSH J. WHITE
C. W. WHITLEY
WILLIAM WRAITH

ZINC

GEORGE C. STONE, *Chairman*

S. E. BRETHERTON
GELASIO CAETANI
C. A. H. DESAULLES
H. W. GEPP
W. McA. JOHNSON
FREDERICK LAIST
DORSEY A. LYON
OTTO RISSMAN
C. E. SIEBENTHAL

MISCELLANEOUS METALS

CHARLES H. FULTON, *Chairman*

SIEGFRIED FISCHER
FRANK L. HESS
ZAY JEFFRIES
ROBERT M. KEENEY
GEORGE A. PACKARD
WALTER M. STEIN
JOSEPH STRUTHERS
WILLIS R. WHITNEY

PLACER DEPOSITS

CHARLES JANIN, *Chairman*

MARK N. ALLING
SIDNEY H. BALL
PIERRE BOUERY
C. C. BRAYTON
NEWTON CLEAVELAND
ROBERT E. CRANSTON
F. LYNWOOD GARRISON
J. J. HAMLYN
W. P. HAMMON
ROSS B. HOFFMANN
HENNEN JENNINGS
E. B. KIMBALL
CHESTER F. LEE
H. L. MEAD
F. L. MORRIS
C. H. MUNRO
WILLIAM S. NOYES
HENRY C. PERKINS
O. B. PERRY

Non-metallic Minerals

HEINRICH RIES, *Chairman*
CHARLES P. BERKEY, *Vice-chairman* GEORGE F. KUNZ, *Vice-chairman*
EDWARD W. PARKER, *Vice-chairman*
WILLIAM C. PHALEN, *Secretary*, U. S. Bureau of Mines, Washington, D. C.

SAMUEL W. BEYER
H. A. BUEHLER
JOHN A. DRESSER
R. D. GEORGE
FRANK L. HESS
F. R. HEWITT
F. C. HOOPER
C. COLCOCK JONES
C. G. MEMMINGER
BENJAMIN L. MILLER
WILLET G. MILLER
JOSEPH HYDE PRATT
KENNETH SEAVER
THOMAS L. WATSON

OFFICERS AND DIRECTORS

For the year ending February, 1919

PRESIDENT

SIDNEY J. JENNINGS, ... New York, N. Y.

PAST PRESIDENTS

L. D. RICKETTS, ... New York, N. Y.
PHILIP N. MOORE, ... St. Louis, Mo.

FIRST VICE-PRESIDENT

C. W. GOODALE, ... Butte, Mont.

TREASURER

GEORGE C. STONE, ... New York, N. Y.

SECRETARY EMERITUS

ROSSITER W. RAYMOND, ... New York, N. Y.

SECRETARY

BRADLEY STOUGHTON, ... New York, N. Y.

VICE-PRESIDENTS

KARL EILERS,[1]	District 0	New York, N. Y.
JAMES MacNAUGHTON,[1]	District 4	Calumet, Mich.
CHARLES W. GOODALE,[2]	District 5	Butte, Mont.
MARK L. REQUA,[2]	District 6	San Francisco, Cal.
HENRY S. DRINKER,[3]	District 2	So. Bethlehem, Pa.
ROBERT M. RAYMOND,[3]	District 0	New York, N. Y.

DIRECTORS

GEORGE D. BARRON,[1]	District 0	New York, N. Y.
EDWIN LUDLOW,[1]	District 2	Lansford, Pa.
CHARLES F. RAND,[1]	District 0	New York, N. Y.
THOMAS B. STEARNS,[1]	District 7	Denver, Colo.
B. B. THAYER,[1]	District 0	New York, N. Y.
J. E. JOHNSON, JR.,[2]	District 0	New York, N. Y.
ALLEN H. ROGERS,[2]	District 1	Boston, Mass.
HOWARD N. EAVENSON,[2]	District 9	Gary, W. Va.
J. V. N. DORR,[2]	District 0	New York, N. Y.
WILLET G. MILLER,[2]	District 11	Toronto, Canada.
FREDERICK G. COTTRELL,[3]	District 6	San Francisco, Cal.
HENNEN JENNINGS,[3]	District 9	Washington, D. C.
GEORGE C. STONE,[3]	District 0	New York, N. Y.
SAMUEL A. TAYLOR,[3]	District 2	Pittsburgh, Pa.
ARTHUR THACHER,[3]	District 3	St. Louis, Mo.

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921.

All communication
AMERICAN IN

Amer

I, ______

residing at ______
(Give a

to be { admitted
transfer

of Mining Eng

I was bo

and am a citize

I was e
(A technic
not re
mem

I gradu

______

______

______

If you wish the Inst
the names of at le
quainted. A list of

I refer t

Give the names of
least five Members
Associates.
This information n
not be given if th
members or associat
sign the proposal bla

FOR MEMBERSHIP

m Constitution

CLE II

MBERS

stitute shall comprise four classes, namely:
Associates; 4. Junior Associates.

l to the privileges of membership, excepting
iates, and Members and Associates whose
d States, Mexico, and Canada shall not be
iates residing within the United States of
n arrears for dues, shall be entitled to vote in
, or, as hereinafter provided for, by letter

all those persons who on the third Monday
Institute, and in addition thereto, all those
class of Members.

of age and must have had at least six years'
g, mining, geology, metallurgy or chemistry,
must have held positions of responsibility in

of a college, approved by the Committee on
lent to two years' employment, as required

ng, mining, geology, metallurgy or chemistry,
position of responsibility as specified in the

scientific literary work or in teaching in the
ed by the Committee on Membership, who
g or in the active practice of mining, geology,
der the time so spent in active practice as
f employment in positions of responsibility,
held seem to the Committee on Membership

oyment in positions of responsibility may be
in the case of persons who have done notable
lurgy, or have won distinction by research or
subjects. By investigation or research is
as distinct from investigations in literature

the opinion of the Committee on Membership
or such election or transfer by reason of their
ology, metallurgy, or chemistry.

se all students in good standing in engineer-
egrees and are nominated by at least three
structors. A Junior Associate may remain
aving the engineering school, at the end of
ne a Member or Associate must be passed
. If elected he shall pay at that time the
sociate.

classification of a candidate the Committee
ny evidence he desires to present and the
er status shall be final.

nber, Associate, or Junior Associate must be
embers or Associates, must be approved by
ribed in the By-Laws, and must be elected

ion"
ared
or of
vhile
ath)
t his
line
wn;
lery
orld.
837.
eon,
own
and
nion

ish-
me,
arly
lder
atic
on-
n's
agi-
vel
elt,
wn

opy
em-
ond
the
ied
ty,
in
ec;

Present position: ______________________________

I agree, if elected, to accept election within four months, and to abide by the Constitution and By-Laws.

Dated ______________________________ 191   *Signature of Applicant:* ______________________________

(Applicant will fill in this date)

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age (Minimum)	Length of Active Practice	Responsible Charge of Work
Member....	Professional Mining Engineer, Geologist, Metallurgist or Chemist.	27 years	6 years*	3 years
Associate...	Any one interested in mining, geology, metallurgy, or chemistry.			
Junior Associate..	Engineering student who has not received technical degree.			

* See requirements for membership on reverse page.

(DO NOT FILL THESE BLANKS)

FOR ADMISSION / TRANSFER OF

Received ______________________________

Bulletin ______________________________

Elected ______________________________

Second Notice ______________________________

Third Notice ______________________________

Final Notice ______________________________

Biographical Notice of James Douglas

BY ROSSITER W. RAYMOND

It is scarcely necessary to augment or amend the "Appreciation" of Dr. Douglas, from the pen of Dr. Albert A. Ledoux, which appeared in January, 1916, in *Bulletin* No. 109 of the Institute. The author of that admirable summary enjoyed the great privilege of expressing while Dr. Douglas was yet among us (though already marked for death) the love and esteem with which we all regarded him. But now that his earthly life has ended, the historian must still be the eulogist. No line need be added or deleted in the portrait of him already drawn; it has only to be accepted now as a true likeness, and hung in the gallery of the immortals, illuminated by the crowning glory of another world.

James Douglas was born at Quebec, Canada, November 4, 1837. His father, James Douglas, was a distinguished physician and surgeon, known in many lands, especially in the Orient, and famous in his own country for his philanthropy as well as his skill, having established and directed for many years the first retreat for the insane in the Dominion of Canada.

One of the latest literary labors of the son was the editing and publishing of his father's journal and reminiscences—a fascinating volume, the review of which, though a tempting task, I must here forego. Nearly fifty years ago, I had the great pleasure of spending an hour with the elder Douglas, who guided me through his collection of Egyptian and Asiatic treasures. I might almost say souvenirs; so many of them were connected with personal experiences and exalted personages. The veteran's memory had already begun to fail with age, but his vivacity and imagination glowed all the more brightly; and his reminiscences of travel and adventure were embroidered with Oriental magnificence. I felt, after that hour, as if I had visited a stately, half-ruined edifice, overgrown with vines and flowers.

The father's genius, adventurous spirit and generous philanthropy descended to his versatile, yet practical son. Like other men of such temperament, James Douglas tried many things before circumstances beyond his own control forced him into the line of his principal lifework. At the age of 18, he was sent to the University of Edinburgh, where he studied for two years. Returning to Canada, he entered Queen's University, at Kingston, Ontario, where he was graduated as Bachelor of Arts in 1858. Subsequently he studied medicine at Laval University, Quebec;

and it was doubtless during this period that he assisted his father in the management of the Quebec lunatic asylum; and also traveled extensively with him in Europe and the East. In connection with his study of medicine at Laval University he became interested in chemistry, which he afterward taught for several years at Morrin College, Quebec. No doubt his excursion in this direction was initiated by his acquaintance with a man who was destined to have a decisive influence upon his future career, namely, Thomas Sterry Hunt, at that time about 33 years old, who was lecturing on chemistry in the French language at Laval. Hunt's prodigious intellectual activity, keen insight into the facts and laws of nature, and fierce enthusiasm in the pursuit of scientific truth (qualities evident enough in later years, but doubtless supereminent in his youthful prime) must have affected profoundly a mind like that of Douglas. The two became close friends and in after years business partners. Yet meanwhile their paths were widely sundered. Hunt continued his brilliant career as chemist and geologist, on the Canada Geological Survey, in the faculty of McGill University, on the juries of successive international expositions, as the recipient of sundry honorary degrees and decorations, as prolific author of notable scientific papers, and finally as Professor of Geology in the Massachusetts Institute of Technology, and one of the most active promoters and officers of the American Institute of Mining Engineers. Douglas, meanwhile, returned to Edinburgh, to continue the study of medicine—choosing, however, this time the more scientific branch of surgery—and pursuing as an avocation at the same time a course on theology, which he carried so far as to receive a license to preach. It is permissible to conjecture that he prophetically foresaw the type of spiritual leader who ministers to both soul and body—a type more fully developed nowadays in the medical missionary, and furnishing for Douglas a welcome compromise, or rather combination, of activities, satisfying at once his love of science and his love of men. But his professional plans were cut short by the pecuniary embarrassments of his father, who had made unfortunate investments in mining schemes. To assist him, the younger Douglas returned to Canada, about 1871.

The investments referred to were in the Harvey Hill copper mines in Quebec, the 2-per cent. copper ores of which could not be economically treated at that time by any known process. Douglas was doubtless familiar with the researches of Sterry Hunt on the reactions between cupric oxide, sulphur dioxide, etc., and had recourse to his old friend in this emergency. Together they worked out the famous Hunt and Douglas process, the original form of which was described by Hunt as follows:[1]

---

[1] T. Sterry Hunt: Remarks on the Hunt and Douglas Copper Process. *Trans.* (1871–73), 1, 258.

The essential principle of this new process * * * * is the dissolving of the oxides of copper by a hot solution of protochloride of iron and common salt. In the action which takes place, the protochloride of iron is converted into peroxide, while the oxides of copper are changed to protochloride and dichloride, the latter of which, though insoluble in water, is readily soluble in a hot, strong brine. From the solution thus obtained, metallic iron throws down the copper in a metallic state, regenerating the protochloride of iron, which is then ready for the treatment of a fresh portion of oxidized copper ore.

The obvious ingenuity and beauty of this process made it very attractive to metallurgists; and for a time it was believed that the treatment of 2-per cent. copper ores had been made economically practicable in this way. It would be easy but tedious to enumerate here the many practical and commercial difficulties which have proved, so far, insurmountable by such methods. In 1893, Douglas himself wrote:[2]

There has been, however, but little patronage extended to wet copper-methods, mainly because we do not possess, within accessible reach of the chemical centers, any large bodies of cupriferous pyrites, whose residues, after the extraction of sulphur and copper, would possess value as an iron-ore. The treatment of the low-grade oxidized ores of the Southwest is awaiting realization. In the past, various attempts have been made to employ old and new wet methods; but none has proved commercially successful, nor has any survived until to-day.

In 1875, Mr. Douglas came to the United States as Superintendent of the Chemical Copper Co., of Phoenixville, Pa., which treated copper ores and pyritic cinders, and also melted and refined base metal. A variety of the Hunt and Douglas process was employed for extraction. It was a small plant, and ill-supplied with capital. I remember examining it while Douglas was in charge, and admiring the courage with which he struggled against technical difficulties, and the ingenuity with which he devised substitutes for expensive apparatus. It was an up-hill business, and after some years of strenuous endeavor, the plant was destroyed by fire. But the discipline of the long contest had made a strong man of Douglas, while his business relations had brought him into contact with many who could not fail to be impressed by his ability and integrity. For some years after the failure of the Phoenixville enterprise, he was without fixed employment, though he did some important consulting work, visiting Montana, Colorado and other mining districts. Concerning the stroke of well earned "good luck" which placed him on the straight road to fame and fortune, I cannot do better than quote the story as told by Dr. Ledoux:

An accident brought him into contact with the old metal house of Phelps, Dodge & Co. When the Copper Queen mine was opened by Martin and Reilly, the first

[2] James Douglas: Summary of American Improvements and Inventions in Ore-crushing and Concentration, and in the Metallurgy of Copper, Lead, Gold, Silver, Nickel, Aluminum, Zinc, Mercury, Antimony and Tin. *Trans.* (1893), **22**, 321 (Chicago meeting, 1893, being part of the International Engineering Congress).

carloads of copper bars were sent to Phoenixville to be refined by Dr. Douglas's works. He had been introduced to Mr. William E. Dodge and had been retained to report on the Detroit Copper Company's mines in Arizona. This firm was conservative in the extreme and, while very large sellers of metals, had but recently entered into the mining field, considering mining somewhat of a gambling venture. Urged by an acquaintance, they had taken an option on the former Copper Queen—the original of the name—in Arizona, and engaged Dr. Douglas to examine it. They agreed to pay his expenses and to furnish him with a certain sum of money with which to test the property, promising that if they took it over on his recommendation, they would place the management in his hands and give him an interest.

The world knows to what great heights Phelps, Dodge & Co. have attained in the mining business. Dr. Douglas, upon the incorporation of the firm, became its President. The writer feels sure that those who have succeeded to the control of this corporation after the deaths of Messrs. William E. Dodge, Senior and Junior, and of Mr. D. Willis James, will not resent the statement that, in the writer's opinion, Dr. Douglas supplied the imagination necessary in all great enterprises, while they supplied the money and equally important careful business management.

The product of the smelter at Bisbee was hauled several miles to the railroad by mules. He put in the first traction engines employed in the Southwest. This method becoming too slow, he built the railroad from Bisbee to Fairbanks, the junction with the Southern Pacific. When the product of the Copper Queen became too great to handle economically at Bisbee, it was his idea to establish at Douglas the beginning of the great smelting plant which today is second to none—if not in capacity, at least in well thought-out installation and correlation of its parts; in efficiency and economy in management.

Looking further ahead than the life of the Copper Queen, it was Dr. Douglas who suggested the taking over of adjoining properties in the Bisbee camp, and the agreement to disregard the law of the apex and questions of extra-lateral right, so there has been no litigation at Bisbee from these fertile sources of trouble in most mining camps.

It was Dr. Douglas again, when fuel became expensive and irregular in delivery, who suggested the organizing of a coal company to supply their own needs and to enable them to sell coal and coke to others without paying tribute in high freights to the railroad. Again, it was his suggestion that their railroad should be extended to El Paso, and that branch lines should be built into Mexico, where, on his initiative, Phelps, Dodge & Co. had already secured important producing mines, destined to add a very considerable tonnage to their output of copper.

In 1875, the year when Douglas came to Phoenixville, he was elected a member of this Institute, and in June, 1876, he entertained at his works a visiting party of its members. Already, thus early in his career, he manifested the quality which was afterward so characteristic of him—a great willingness to communicate, as well as to receive, the results of discovery and practice. The Institute, founded to promote this open interchange of professional knowledge, appealed peculiarly to his mind, which disdained to harbor secrets. Through the five years in which he bravely fought at Phoenixville a losing fight, he remained in the Institute; but when that enterprise had failed, and he was obliged to begin again somewhere else, he resigned his membership, the annual expense of which he could not conscientiously afford. But after professional

recognition and business success had returned to him, he secured reinstatement in that relationship and thenceforth unto the end was in every way a loyal, potent and munificent supporter of the Institute. I mention this episode of his temporary retirement, because it was influential in the history of the Institute itself. For years after Dr. Douglas had become a leader in its management (he was Vice-president in 1897–8, President in 1899–1900, Director from 1905 to 1913, Honorary Member from 1906, and Vice-president of the Board of Directors from 1906 to 1911) he was a strong opponent of the increase of annual dues. Even after the acceptance by the Institute of Mr. Carnegie's gift (involving a heavy land-debt), he was not willing to meet additional expenses in that way. "I remember," he used to say, "when even ten dollars a year was too great a burden for me; and I will not vote to lay a heavier load upon young American engineers." I promised, as Secretary, to take care of all office expenses out of the annual dues as they stood; and that promise was kept. But it was not possible to make payments also upon the land-debt; and we proposed to pay that by subscription. This is, indeed, what was finally done; and, without disparaging the liberality of other subscribers, it must be said that the early success of the movement, which paid the whole debt ($180,000 and interest) ten years before the final payment was due under the terms of the mortgage, was chiefly the work of James Douglas. It is true, that after this achievement, the Institute was unable to meet its running expenses without raising the dues to $12, and Mr. Douglas was beaten on that point, after all. But the whole story shines with his generous and sympathetic courage.

One day, in a private talk over Institute affairs, I would have cautioned him against a too reckless giving away of his money; but he cut me short by saying, "This year, for the first time in my life, I have what I may call a large—really, Raymond, a very large—income; and I mean to get some pleasure out of it!"

At the time when Phelps, Dodge & Co. became a corporation, the members of the firm set aside $10,000 as a gift to Dr. Douglas, in recognition of his past services. But under his earnest persuasion, they gave the money to the Institute land-fund instead, in addition to their earlier subscription of some thousands of dollars. He was himself also at that time already a large subscriber.

This does not exhaust the list of his benefactions to the Institute. After the land-fund had been completed, he gave $100,000 to the Library; and it is reported in the newspapers that he left to the same object $100,000 more in his will.

Dr. Douglas's contributions to our *Transactions* are shown in the following table:

PAPERS

Title	Vol.	Page	Year
The Copper Resources of the United States	xix	678	1890
Biographical Notice of Thomas Sterry Hunt	xxi	400	1892
Summary of American Improvements and Inventions in Ore-crushing and Concentration, and in the Metallurgy of Copper, Lead, Gold, Silver, Nickel, Aluminum, Zinc, Mercury, Antimony and Tin	xxii	321	1893
Note on the Operation of a Light Mineral Railroad	xxviii	600	1898
Notes on the Stockholm Exposition and the Iron and Steel Trade of Sweden	xxviii	101	1898
American Transcontinental Lines	xxix	782	1899
The Characteristics and Conditions of the Technical Progress of the Nineteenth Century	xxix	648	1899
The Copper Queen Mine, Arizona	xxix	511	1899
Biographical Notice of William Earl Dodge	xxxiv	412	1903
Secrecy in the Arts	xxxviii	455	1907
Conservation of Natural Resources	xl	419	1909

DISCUSSIONS

Title	Vol.	Page	Year
Summary of American Improvements and Inventions in Ore-crushing and Concentration, and in the Metallurgy of Copper, Lead, Gold, Silver, Nickel, Aluminum, Zinc, Mercury, Antimony and Tin	xxii	647	1893
Stockholm Exposition and the Iron and Steel Trade of Sweden	xxviii	813	1898
The Copper Queen Mine, Arizona	xxix	1056	1899
Corrosion of Water-jackets of Copper Blast Furnaces	xxxviii	879	1907
Coal-briquette Plant at Bankhead, Alberta, Canada	xxxix	894	1908
Conservation of Natural Resources	xl	878	1909

Besides these professional papers, and many of the same class read before other technical societies, Dr. Douglas published the following books:

Canadian Independence, Annexation and Imperial Federation.

Old France in the New World.

New England and New France.

Journal and Reminiscences of James Douglas, M.D., Edited by his son.

He received the degree of LL.D. from both Queen's University (of which he was Chancellor when he died) and McGill University, of which he had been a trustee for many years. In 1906, the gold medal of the Institution of Mining and Metallurgy of Great Britain, and in 1916 the John Fritz gold medal, were awarded to him. In 1906, as already mentioned, he was elected an Honorary Member of this Institute, and in 1907 the same title was conferred upon him by the Mining and Metallurgical Society of America. He was a member of the American Philosophical Society, the American Geographical Society, the Society of Arts, of London, the Iron and Steel Institute, and other learned and professional bodies.

Besides his munificence toward this Institute, Dr. Douglas was a liberal benefactor of many good causes and institutions and of innumerable individuals. A few instances only can be mentioned here. A much larger number will never be publicly known. In addition to his generous gifts during his life, he bequeathed $100,000 to the American Museum of Natural History, $100,000 to this Institute, $100,000 to the General Hospital at Kingston, Canada, and $50,000 to McGill University, besides legacies to many employees.

In short, he lived long enough to realize the purpose of his life, and to "get some pleasure out of it."

Dr. Douglas in 1860 married Miss Naomi Douglas, daughter of Captain Walter Douglas, of Quebec, who survives him, together with two sons and two daughters: Major James F. Douglas, developer of the United Verde Extension Mine, who is now serving in France; Walter Douglas, who succeeded his father as President of the Phelps-Dodge Corporation; Mrs. Edith M. Douglas, wife of Archibald Douglas, a New York lawyer of extensive mining interests; and Miss Elizabeth Douglas.

Good-by for a while, James Douglas!—unwearied worker, courageous leader, wise counsellor, glad giver, faithful lover and friend—"Douglas, Douglas, tender and true!"

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the Colorado meeting, September, 1918, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Oct. 1, 1918. Any discussion offered thereafter should preferably be in the form of a new paper.

Method of Fixing Prices of Bituminous Coal Adopted by the United States Fuel Administration*

BY CYRUS GARNSEY, JR., R. V. NORRIS, AND J. H. ALLPORT†

(Colorado Meeting, September, 1918)

Necessity for Price Fixing

During the latter part of 1916 and the early months of 1917, due to war activities, there was a threatened shortage of coal which resulted in panic among consumers and a rush to obtain coal at once at any price. As a result of this insistent demand for immediate delivery, prices were bid up by the consumers to unprecedented heights; spot coal which had previously been selling at from $1.50 to $2 per ton was bid up to $5, $6, and, in exceptional cases, as high as $7.50 or more per ton. Then when the April, 1917, contract period arrived, contracts could be made only at prices ranging from $3 up to $5 and $6 per ton for the year's delivery.

This condition caused such a demoralization of the business, and so much complaint, that some action to regulate prices was considered essential by the National Administration.

Lane-Peabody Agreement

In May, 1917, a committee under the chairmanship of F. S. Peabody, of Chicago, was appointed by the Council of National Defense, through Mr. Lane, to consider the whole question of bituminous coal. This committee, with the Secretary of the Interior, Mr. Lane, after numerous meetings and long negotiations with the operators throughout the country, announced on June 29 an agreement between the Committee and the producers, fixing a tentative maximum price for bituminous coal throughout the country at $3 per net ton f.o.b. mines, to which was added 25 c. for selling commission to wholesalers.

This plan was based on the idea of fixing a maximum price, high enough to greatly stimulate production, with the expectation that the laws of supply and demand would, with ample production, operate to maintain fair and just prices for coal throughout the country.

* Read before the Anthracite Section, Wilkes-Barre, Pa., Aug. 10, 1918.

† Engineers to United States Fuel Administration.

THE "LEVER ACT"

With the country plunged into the greatest war of history, it became evident that distinct power should be given the Administration to control efficiently war necessities, food and fuel, needed in ever-increasing amounts, not only by our own country but by our allies, and for our armies in this country and abroad. With this in view, the Sixty-fifth Congress passed House Bill No. 4961, generally known as the "Lever Act," entitled "An Act to provide further for the national security and defense by encouraging the production, conserving the supply, and controlling the distribution of food products and fuels." It was approved Aug. 10, 1917.

Section 5 of the Lever Act authorizes the licensing of "the importation, manufacture, storage, mining or distribution of any necessities;" and Section 25, "to fix the price of coal and coke, whenever and wherever sold, either by producer or dealer." It is further provided in this section "in fixing maximum prices for producers, the commission shall allow the cost of production, including the expense of operation, maintenance, depreciation and depletion, and shall add thereto a just and reasonable profit." "In fixing such prices for dealers the commission shall allow the cost to the dealer and shall add thereto a just and reasonable sum for his profit in the transaction."

[The powers of the Federal Trade Commission as to coal were, with certain minor exceptions, transferred to the United States Fuel Administration by order of the President on July 3, 1918.]

THE "PRESIDENT'S PRICES"

On Aug. 21, 1917, the President announced prices for bituminous coal throughout the United States, specifying prices for run-of-mine, prepared sizes, and slack or screenings, by States and, in a few instances, by districts or by seams. These prices for run-of-mine coal varied from $1.90 to $3.25, and were, in general, a very great reduction from the prices fixed by the Lane-Peabody Commission.

These prices were based on average figures on about 100,000,000 tons production, prepared by the Federal Trade Commission, from the very meager data in its possession, generally costs from the larger and lower-cost operations of each district.

THE FUEL ADMINISTRATION

On Aug. 23, 1917, Mr. Harry A. Garfield was appointed United States Fuel Administrator by the President, and to him was delegated the powers as to fuel, conferred by said act on the President. On the same day, by Presidential proclamation, prices were fixed on Pennsylvania anthra-

cite coal. From this date until early in January, 1918, numerous revisions and adjustments of "The President's Prices" were made by the Fuel Administrator, but no general verification or revision was attempted.

Early in January, the Engineers' Committee was constituted, and to this Committee was entrusted the making of a general review of costs, and the submission to the United States Fuel Administrator of the results of careful studies of the costs of producing coal throughout the United States. The Committee was not then, and never has been, authorized to fix prices on coal; the limit of its duties has been to study and report on methods of price fixing and to determine and furnish costs, leaving to the Fuel Administrator the personal duty of determining the amount of margin to be allowed.

The Committee's first work was a study of price-fixing methods which were, or might be, applicable to coal-producing conditions. In arriving at a logical and scientific plan for fixing the price of fuel the following methods were considered:

1. *Straight Cost Plus Method.*—The actual cost at each colliery plus a fixed sum or percentage of profit.

2. *Modified Cost Plus Method.*—The actual cost at each colliery plus a graduated profit decreasing as costs increase.

3. *Average Cost Methods.*—Prices fixed on the average cost in each district.

4. *Pooling Methods.*—All coal sold at the average cost of each district plus a profit, and the returns to each colliery adjusted through a clearing house at a price proportioned to its cost of production.

Discussion of Advantages and Disadvantages of These Methods

1. *Straight Cost Plus Method*

Advantages.—(*a*) All producers would receive the same profit, and no one would have an advantage over another in this respect.

(*b*) Apparently simple in plan and execution.

Disadvantages.—Impracticable of application, by reason of:

(*a*) Resultant multiplicity of prices, with grave disturbance of markets.

(*b*) Continual changing of prices due to inevitable variations in each producer's costs.

(*c*) Instability of the industry, due to the natural disposition of consumers to purchase the lowest-price coal.

(*d*) Inefficiency in operation always resulting from lack of incentive in cost plus operations.

(*e*) Material reduction in output and reduction in quality due to the

natural tendency to mine the poorer and more expensive coal with a guaranteed profit, and to leave the better and cheaper coal in reserve to be mined on the return of normal conditions.

(*f*) Continual increase in all costs incident to extravagant methods encouraged by guaranteed profits.

(*g*) Labor unrest and constant demands for increases due to the knowledge of a guaranteed profit regardless of cost.

(*h*) Practical impossibility of arriving with technical accuracy at the costs of each separate operation.

(*i*) Impracticability of the Government's policing the mines and securing the same efficient operation and production attained by the individual producer under the stimulus of increased profits.

(*j*) Illogical, in that the better planned and managed operations are discouraged, as compared with poor and inefficiently managed properties.

2. *Modified Cost Plus Method*

This is but a modification of the preceding, and the same discussion applies, modified only by the inclusion of a somewhat greater incentive to the better and more economical operations.

3. *Average Cost Methods*

Advantages.—A minimum uniform price for each district or, if desired, for the entire country.

Disadvantages.—(*a*) The average cost is necessarily less than the cost of about half the total tonnage. Hence, a reasonable profit put on the average cost would not produce the necessary tonnage.

(*b*) The tonnage below and up to the average cost is actually produced by less than 30 per cent. of the operators of the country. Hence, the great majority of the operators producing at above average cost would be put out of business by a price based on the average.

4. *Pooling Methods*

Pooling may be done on either cost plus, modified cost plus, or on the prices established by the United States Fuel Administration.

Advantages.—(*a*) A uniform price to consumers for sections and, if desired, for the entire country.

(*b*) A *present* lower price to consumers based on weighted average cost.

(*c*) A simplification of all present pooling arrangements, as all coal to each pool would have, or could be arranged to have, the same price.

(*d*) A return to the consideration of quality instead of cost, as, with

all coal at the same price to consumers, the higher qualities would naturally be preferred.

Disadvantages of Pooling Cost Plus or Modified Cost Plus Methods.—

(*a*) Continual variation in pool prices, due to inevitable variations in producers' costs.

(*b*) Unfair and illogical, in that the better located and managed operations are made to pay tribute to the poor and badly managed ones.

(*c*) A general and considerable increase in cost inevitably resulting from any method involving guaranteed profits with a disregard of economy.

(*d*) A material reduction in output, due to lack of incentive and resulting inefficient methods, the employment of unnecessary labor, the mining of the more expensive and less desirable qualities of coal for the ultimate benefit of the mines, and the execution of development not immediately needed.

(*e*) A slacking of the efforts of employees, which is the usual result of a lack of incentive to the producer, with the resulting lack of interest.

(*f*) The installation of an unsound policy tending to encourage the inefficient and discourage the efficient producer.

(*g*) The ever-present temptation to allow costs to increase with the hope of readjustment of prices.

(*h*) Dissatisfaction to both labor and to producers from the knowledge that other and less efficient operations have higher limits of price.

The disadvantage of pooling on the prices fixed by the United States Fuel administration are the same as suggested above, without some of the special disadvantages of cost plus methods.

Disadvantage of Pooling in General.—(*a*) A very large capital required to handle such stupendous operations.

(*b*) Enormous and extended credits required to finance the producers.

(*c*) Lack of organization to handle this new business.

(*d*) Undesirability of creating such an organization with its army of additional employees at the present time.

(*e*) Inadvisability of putting a new and untried plan into operation at the present time.

(*f*) Impossibility of obtaining, with sufficient promptness, the costs necessary to fix pooling prices with the necessary accuracy.

(*g*) Interference with present established methods of handling coal, with serious risk of crippling its distribution and unnecessarily creating a shortage.

None of these suggested methods seemed to fill the peculiar conditions incident to price fixing of coal at the mines, and it devolved upon the Engineers' Committee to develop some method better suited to the conditions of the problem.

The Price Fixing Method Adopted

The study of the conditions indicated the necessity of finding a method of price fixing which would fill as nearly as practicable the following requirements:

1. Result in a price fair to the public.
2. Prevent excessive prices or profiteering.
3. Prevent a multiplicity of prices in any district.
4. Encourage legitimate production.
5. Discourage production from inefficient and unduly costly operations.
6. Insure to the producer "the cost of production, including the expense of operation, maintenance, depreciation, and depletion, with a just and reasonable profit," as required by the Lever Act.

In arriving at a method promising to accomplish these results as nearly as practicable, the following system was developed. Costs obtained from the individual sheets filed by each operator with the Federal Trade Commission were studied, listed, and adjusted for price fixing. These figures, with the percentages of each cost in the total production of each district, were plotted on diagrams, showing graphically the range and extent of variation in each district. On these diagrams a line indicating the sources of indispensable tonnage, christened "the bulk line," is drawn as a base to which the Fuel Administrator personally adds a margin in his judgment necessary for each district.

Advantages of this System

The method of fixing prices by the "bulk line" principle recognizes the economic syllogism that "the price of any article necessary to a community will be fixed by the cost of producing that necessary portion of such article involving the greatest expense."

(*a*) This assures to all producers profits dependent upon their ability and exertions, only limited by the establishment of a reasonable price to the consumer.

(*b*) It does not unduly increase the price of coal to the consumer over the minimum price possible under other methods.

(*c*) It tends to encourage maximum production and necessary development by allowing to the producer the benefit of reduced costs due to greater production.

(*d*) It avoids bad feeling among the producers and among the workmen by allowing a fixed price in each district and not apparently showing favoritism to special producers.

(*e*) It tends to encourage the fit and discourage the unfit.

(*f*) The method is susceptible of refinement and extension, making it

possible to eliminate undue profits to the producer and adjust prices from time to time to the ultimate advantage of the consumer.

Disadvantages of This System

(*a*) Considerable profits to the lowest-cost operators.

(*b*) A price for coal greater than one based on the average cost, by the amount by which the "bulk line" exceeds such average.

This method appeared to be better suited to the conditions than any of the others suggested, and after a careful study by the U. S. Fuel Administrator, it was adopted.

Cost Data Available

The Federal Commission had, by authority of the Act of Congress creating the Commission, the power to investigate costs, and to require, under penalty, reports of costs of operation. Under this authority, the Commission sent out, to each coal producer listed in the United States, blanks requiring a rather complete and detailed statement of costs of operation, and the realization obtained from the sale of this product.

These reports were generally available for the months of August and September, 1917, at the time the revision of prices was started, and reports for these two months, studied in connection with later reports, were generally used as a basis of costs for the first studies. It further developed that these two months were, in most instances, fairly representative, as to output, of the average of the year.

Analysis and Adjustment of Cost Sheets

Without desiring to impugn either the honesty or the accuracy of the cost sheets as presented, it was found essential to study and adjust them for use as a basis of scientific and accurate cost finding. Besides correcting slips and palpable mathematical errors, a considerable amount of revision was necessary. Many, especially of the small operators, were inexperienced in bookkeeping and submitted cost sheets which, while accurate in totals, were grievously mixed in details.

Supplies

The item of supplies was found to vary so widely in the same mines in different months that the returns for single months were practically abandoned, and the figures were replaced by averages from all reports available, resulting in increases or deductions from the monthly costs as reported.

FEDERAL TRADE COMMISSION

FILE No.........

BITUMINOUS COAL REPORT ON COST, INCOME, AND TONNAGE FOR ...., 191
(Period, Month or Year.)

COMPANY MAKING THIS REPORT { FULL NAME..............................
ADDRESS.................................. }

LOCATION OF MINES

District...........................
State...............................
County.............................

Mail to FEDERAL TRADE COMMISSION, WASHINGTON, D. C., on or before .
, 1917, the information required on this form.

The information required by this report is ordered to be furnished of the Commission under subdivision b of section 6 of "An Act to c[illegible] Commission, to define its powers and duties, and for other purposes," a[illegible] section 25 of "An Act to provide further for the national security and the production, conserving the supply, and controlling the distributio[illegible] fuel," which is as follows:

"The books, correspondence, records, and papers in any way referring to transactions of any kind relating to the mining, production, sale, or distribution of all mine operators or other persons whose coal and coke have or may become subject to this section, and the books, correspondence, records and papers of any person applying for the purchase of coal and coke from the United States shall at all times be subject to inspection by the said agency."

PENALTIES

Failure to [illegible] ...e cor-
poration to a[illegible] ...of the
continuance [illegible] ...Act.
Any perso[illegible] ...entry
or statement [illegible] ...s than
$1,000 nor m[illegible] ...s than
three years o[illegible] ...ederal
Trade Commission Act.

COST

	ITEM	LABOR	SUPPLIES	TOTAL AMOUNT	TOTAL PER TON
	I. MINE EXPENSE	$	$	$	$
(1)	OPERATING EXPENSE:				
(2)	Mining,				
(3)	Yardage,				
(4)	Transportation,				
(5)	Ventilation,				
(6)	Drainage,				
(7)	Dead work,				
(8)	Tipple or breaker,				
(9)	Washery,				
(10)	Miscellaneous,				
(11)					
(12)	Total,				
(13)	Power,				
(14)	Power house fuel, tons,				
(15)	Superintendence and engineering,				
(16)	Mine office,				
(17)					
(18)	Total,				
(19)	TOTAL OPERATING EXPENSE,				

INCOME

			AMOUNT
			$
(63)	COAL SALES:		
(64)	Local sales,	at per ton,	
(65)	Shipped,	at per ton,	
(66)	Railroad,	at per ton,	
(67)	Coke,	at per ton,	
(68)	Power-house fuel,	at per ton,	
(69)			
(70)	TOTAL SALES,		
(71)	COST OF SALES:		
(72)	Total mine expense (Item 35),		
(73)	Coal purchased,		
(74)	Total,		
(75)	Inventory 1st of month,		
(76)	Inventory end of month,		
(77)	Increase or decrease in inventories,		
(78)	TOTAL COSTS (Add 74 and 77),		
(79)	GROSS PROFIT ON COAL SOLD (Subtract 78 from 70),		

(20) GENERAL EXPENSE AND FIXED CHARGES			
Royalty,			
Depletion reserve,			
Depreciation reserve,			
Maintenance reserve,			
Contingent reserve,			
Taxes (exclude income and excess profit), %			
Insurance—General,			
" Liability, or Compensation,			
Officers' salaries and expenses,			
office salaries and expense, %			
(33)			
(34) TOTAL GEN. EXP. AND FIXED CHARGES,			
(35) TOTAL MINE EXPENSE,			
II. SELLING EXPENSE			
(36) Commissions,			
(37) Advertising,			
(38) Bad accounts,			
(39) Allowances,			
(40) Salesmen's salaries and expenses,			
(41) Officers' salaries and expenses,			
(42) Other office salaries and expenses, %			
(43) Miscellaneous,			
(44)			
(45) TOTAL SELLING EXPENSE,			
III. OTHER EXPENSE			
(46) Taxes—Income and excess profit,			
(47) Interest,			
(48) Sinking fund,			
(49)			
(60) Total,			
(61) Supplies used during month,			
(62) Supplies on hand end of month,			

ent,

...E. (2,000 Pounds)

	PREPARED	RUN-OF-MINE	SLACK	TOTAL
(97) SALES:				
(98) Local,				
(99) Shipped,				
(100) Railroad,				
(101) Coke,				
(102) Power-house fuel,				
(103) TOTAL SALES,				
(104) Add				
(105) Inventory, end of month,				
(106) TOTAL,				
(107) Deduct				
(108) Inventory 1st of month,				
(109) Purchased coal,				
(110) Total deductions,				
(111) PRODUCTION,				

(112) Kind of coal, Number days worked,
(113) Name or number of seam, Cause of idle days,
(114) Thickness of seam,
(115) Number of mines,
(116) Remarks:

APPROVED AND CERTIFIED CORRECT: ....
(Name.) (Title.)

This Report Must be Signed by an Officer of the Company.

Reserves

The item of maintenance was frequently misunderstood, in some instances all supplies and much labor being charged to this account; in others a fixed sum, and in still other cases, nothing at all was charged.

Depreciation was often put in as a guess; in some cases it was frankly stated that this seemed a good time to charge off improvements, and such were charged to the limit, and beyond.

Depletion of lands was also an item which appeared greatly to trouble some of the accountants. While generally understood, many very wild guesses, even up to the market price of the product, were found; also, many instances of depletion charges for lands operated on royalty or alese and not the property of the operator.

Contingent funds noted on the blank were generally omitted but, in a few cases, especially when the need of such funds had recently been felt, most ample allowances were made. After being considered, it was decided to apply in each district amounts obtained by studying the claims of the better operators of such district, after obtaining, from the best available sources, reliable figures as to the cost of lands and amount and value of improvements characteristic of the district.

The question of contingent reserves is a serious one. From a strict cost-accounting standpoint, no cost can be permitted until incurred. Nevertheless, such reserves are essential to an industry involving the great risk incident to coal mining, and with the full knowledge that such reserves are used only for major accidents or calamities, and that ordinary losses regularly incurred are charged to the costs of operation, it was decided to include a small amount for contingent reserve in the general allowance.

Salaries

Executive and even superintendent's salaries were frequently omitted. In many cases of personal ownership, undoubtedly none were paid. It was considered only just to add to such returns reasonable allowances for salaries to place such reports on a parity with the majority of the operations which paid for such necessary service. On the other hand, occasional instances were found of reported salaries so excessive as to require adjustment downward to a reasonable parity with the general practice of the district.

A sliding scale of salaries adjusted, within broad limits, to the monthly tonnage of an operation was finally devised. Any salaries missing or below the minimum allowed were raised to the minimum, and those above the maximum were lowered to the maximum.

Special Charges

Special charges were generally treated in detail, often spread over a reasonable time rather than allowed in a single month. In treating these a careful study of all reports available was made.

Special Records

The Federal Trade Commission had required special explanations of all charges out of the ordinary, and all these records were available and were carefully studied and had great influence in deciding doubtful points.

Outside Profits

The profits from farms, dwellings or stores are not properly mining profits, and accounts of these should be kept separate from mining expense. Where it is found that such accounts are separated, no deduction for such profits should be made, but where dwellings, particularly, are so intimately connected with the mining that no separation is possible, it is proper to include their operation with mining accounts.

Fuel for Power

In general, charges for fuel for colliery power were allowed, and the tonnage divisor was made to include such fuel. In the opinion of the Committee it would, however, be advisable to eliminate colliery fuel from both sides of the account, and merely to keep a record of the amount used; by this method, the tonnage divisor represents the amount shipped and sold and is susceptible of accurate determination, while the fuel used is approximated, or even guessed at, too often to make the general records containing this item reliable.

Other items requiring occasional adjustment were the inclusion of washing costs, for which an extra charge is allowed, in the mining cost, and the inclusion of labor and supplies used in coking operations conducted by the same operators. In a few instances, the coke tonnage, or a mixed tonnage of coal and coke, was reported and used as a divisor to obtain costs per ton, resulting, of course, in a notably excessive cost.

In general, each and every cost sheet was studied carefully by at least one member of the Committee, all adjustments were considered by at least two, and only such adjustments were made as were warranted by the conditions and the necessity of placing all costs on the same basis, so as to find a just basis of cost for fixing the prices for each district.

Reporting Costs

The great mass of cost figures, obtained from the above analysis of the cost of operators mining over 95 per cent. of the entire production

of bituminous coal in the United States, would be merely confusing and of but little practical value if presented in tables of figures, and it was considered necessary to devise some plan to present these graphically so that they might be studied and compared with a minimum of effort and with maximum efficiency. After many trials, a chart was evolved which appears to have satisfactorily accomplished the ends sought.

The costs for each district, both exactly as reported and as adjusted, were arranged in order by 1-c. increments, beginning at the lowest cost, with the tonnage at each separate cost, whether from one or more operations; the percentage of total tonnage at each cost was calculated, and the cumulative percentage beginning at the lowest-cost tonnage was obtained.

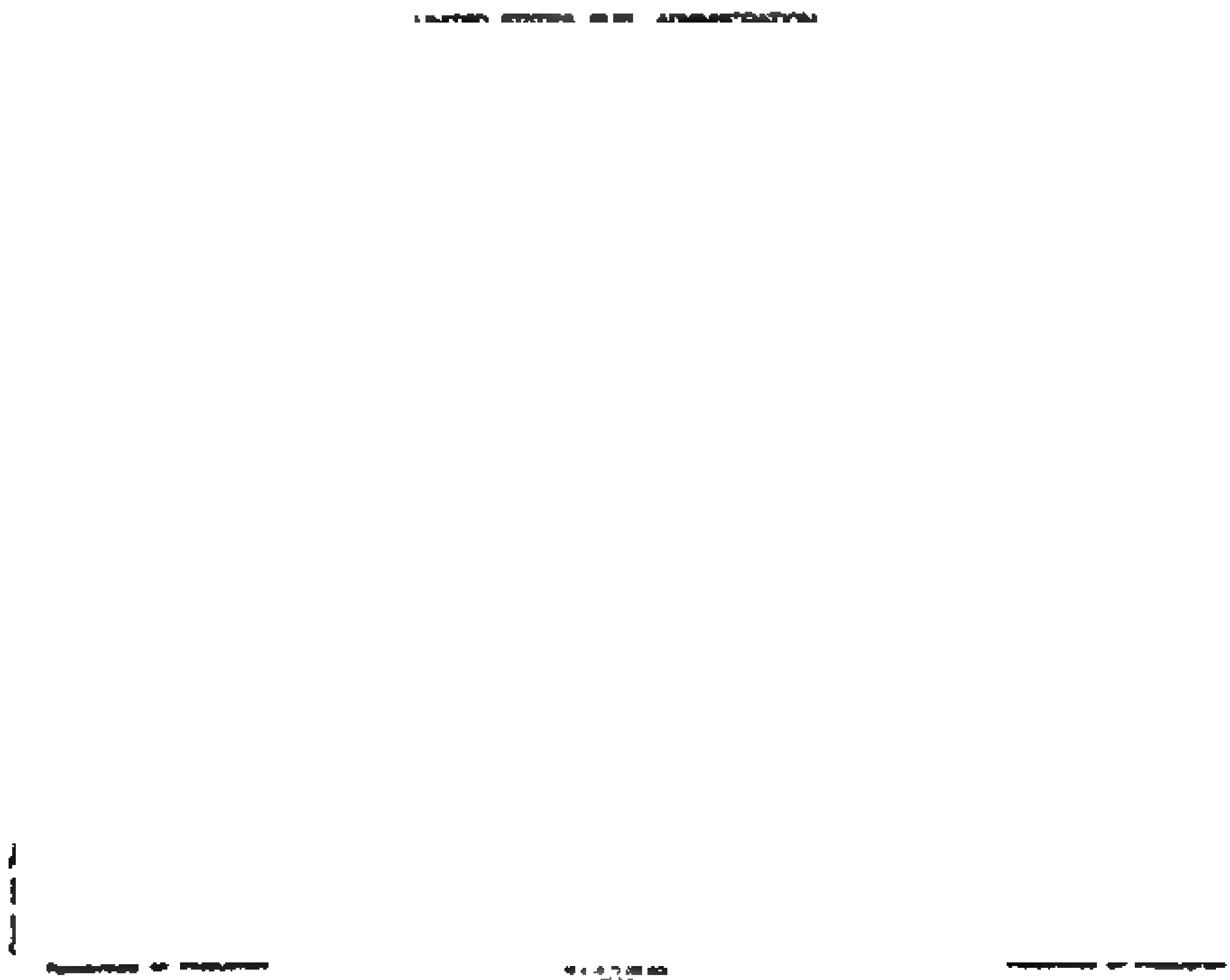


Fig. 1.

Charts

The percentages thus obtained were plotted on 10 by 10-space cross-section paper, resulting in a diagram like Fig. 1.

The dotted line shows the costs reported, and the full line the adjusted costs. The percentage of the total output between, or up to, any limits of cost can be determined by simple inspection. The "bulk line," or

line of indispensable coal which must be assured of a minimum profit, after study of the conditions and necessities of any district, can be properly located, and from this a minimum profit necessary for the district can be determined.

Adjusting the "Bulk Line"

The "bulk line" is a matter requiring very careful study. Its location must be such as to conserve and encourage all necessary operations and thus assure the maximum coal supply from each district.

It is almost invariably found that at the high-cost end of the diagram are collected most of the doubtful enterprises. These include: mines which have failed under normal competitive conditions and have been reopened under the stimulus of the high prices preceding Government control; mines abandoned as exhausted and reopened for the few remaining pillars; new enterprises in the development stage; mines opened on beds so thin or of such poor quality that they could not operate under normal conditions; small mines on outcrop coal, often of poor quality, which have neither capital nor equipment for economical working; mines which have encountered faults or in which the coal has thinned or split, or the quality has so deteriorated as to prevent working at a reasonable cost; and, not the least of this group, mines so badly managed as to show unwarrantable costs of operation.

All these classes of mines are unjustifiable under war conditions. They use labor inefficiently. Often their records show less than half the tonnage per employee usually obtained in their district, and their elimination is an economical advantage to a district in releasing labor to more efficient mines.

In this high-cost group occasionally are found mines which have a coal of unusually high quality or fitted for special use, for which a market at prices above those of the district has always existed. Such mines, on proving their special conditions, may receive consideration for special prices sufficient to allow a fair profit on their higher costs.

After a study of all conditions, the "bulk line" is located as far as possible to exclude the classes of operations above mentioned, and to include all mines operating economically and efficiently. The margin above the "bulk line" is sufficient to allow all but a very small percentage of the tonnage to be produced without actual loss, but with less than the minimum profit applied to all mines up to the "bulk line."

The charts have the further advantage that they show all the costs of any district without divulging the costs of any operation, yet by a very simple system of confidential keys the position of any separate operation can be almost instantly found and its cost sheets located.

The charts have the further advantage that almost any desired information as to costs or tonnage, averages, totals within desired limits,

margins, excessive and subnormal costs with the tonnage involved, and other items of information often required, can be obtained very rapidly and with a minimum expenditure of time or labor. On one occasion, two members of the Committee calculated in a single evening the weighted average costs, both reported and adjusted, for over three-fourths of the entire bituminous coal output of the country.

Districting

It is inevitable that mines should show wide variations in cost, due to the varying thickness and character of the beds worked, and to apply a single price to all the mines of a State would result in either allowing an unreasonable profit to those working the better and thicker beds, or absolutely put out of business the higher-cost districts.

Where an area examined shows wide variations of cost, it becomes necessary to employ some plan of separation, and to segregate into groups those mines operating under similar conditions. Such districting may be based on difference in beds, on thickness of coal, or by geographical and geological districts.

Districting by beds is only occasionally practicable, for the following reasons:

(*a*) Variation in thickness and quality in the same bed.

(*b*) Difficulty of identification of beds.

(*c*) Splitting of beds, changing one thick bed to two or more thin ones.

(*d*) Changes in mining conditions in the same bed, making radical differences in cost of mining.

Districting by thickness of beds seems at first glance the most logical method, but it has the fatal objection that, as nearly all beds become thin in places, two or more costs will be found in contiguous mines and often in the same mine. Further, this districting leads to gross profiteering, by attempting to classify mines by the thinnest coal, not by the average.

The terms "thick" and "thin" beds are particularly dangerous, as what would be considered thick in one region may be classed as thin in another, and the reverse; it is therefore manifestly undesirable for the United States Fuel Administration officially to designate any particular thickness as the dividing line between thick and thin.

Districting geographically has the great advantage of making divisions susceptible of accurate description and eliminating all questions as to the proper price applicable to any colliery. It generally puts together mines having the same conditions and normally competing, avoids varying prices for coal of the same quality and character, and simplifies distribution and marketing. The difficulties in applying this method are greatest in fields where numerous beds of varying thick-

ness and character are worked, resulting in considerable variations in price. It is also frequently difficult properly to classify operations near the borders of adjoining districts, and geographical districts are hence necessarily subject to some adjustment of boundaries.

Further, in designating districts, labor conditions are necessarily carefully considered. Neither miners nor operators wish to have the scale of wages changed in any mine by the throwing of such mine from one wage district to another, and before deciding on the boundaries of districts, it has been found essential to obtain the wage-scale and the

FIG. 2.

boundaries of wage-scale districts. Further, it is found that in making up the wage-scales, some very accurate districting has been done, and maps showing these wage districts are of great assistance in the final determination of proper boundaries.

It is the practice of the Committee to classify mines under study, first by counties or fields, and then to separate or combine them, as the case may be, to obtain districts containing, as far as practicable, mines operating under the same general conditions.

Diagrams 2 and 3 show the result of districting in an important territory producing about 75,000,000 tons of coal per year. Diagram No. 2

shows the costs for the entire area, and the very wide variations in cost due to different mining conditions are apparent. Diagram No. 3 shows the costs in the three districts finally segregated. These all permit price fixing without giving excessive profit, or putting the high-cost districts out of business, thus assuring the mining of the required tonnage of coal.

It will be noted in the three-district diagram that the low cost of No. 1 corresponds with the high cost of No. 2, and the low of No. 2 with the high of No. 3. If prices had been fixed on Diagram No. 2, for the entire State, the "bulk line" would have been placed at about $1.90. This would

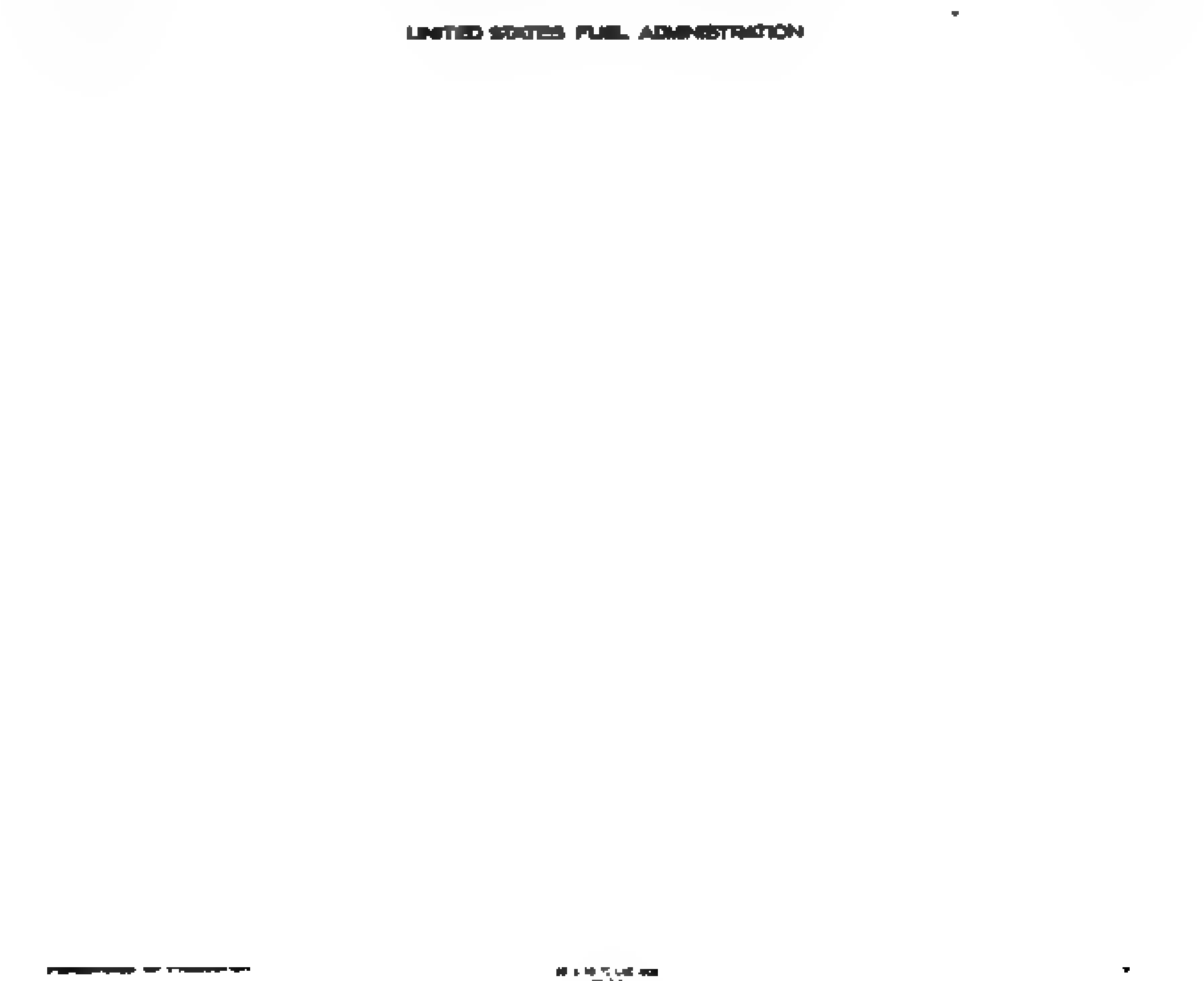


FIG. 3.

have put the whole of District No. 1 and 36 per cent. of District No. 2, or a production of about 500,000 tons per month, above the bulk line, giving these regions an insufficient margin, and checking production, if not stopping it; at the same time, it would have given to District No. 3, producing 5,700,000 tons per month, 30 c. per ton or over $1,700,000 per month unnecessary margin. Similar conditions throughout the country have been handled in this manner.

It will also be noted that the variation between high and low costs increases with the higher-cost districts. The angle of slope of the cost line increases from No. 3 to No. 1. This results in a somewhat greater

margin between the average cost and the "bulk line," which is logical and necessary. The high-cost mines, having greater expenses, need a larger margin to attain the same percentage of profit. As an example of the districting necessary in exceptional cases, Fig. 4 is a map of the districts in West Virginia. On fixing prices for these, only seven different prices were found necessary for 13 districts.

Price Fixing

The "bulk line" of the chart, with the margin added by the Fuel Administrator, gives the necessary realization for a district, but it does

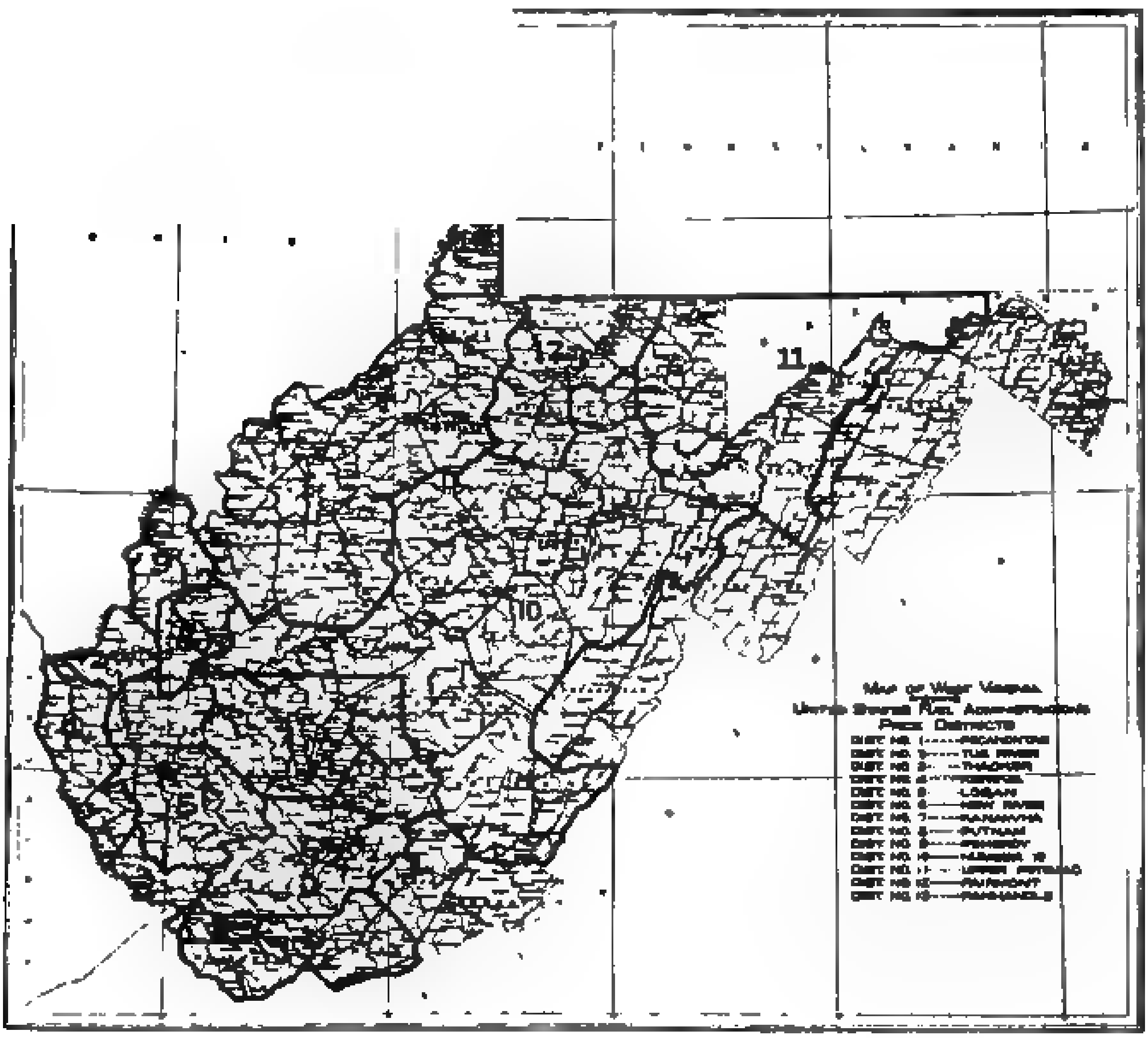


Fig. 4.

not completely fix prices. The price for run-of-mine is usually fixed at the realization price, but where screening is desirable it is necessary to fix a spread of price so that the operator receives as much as 1 c. or 2 c. more for the screened product than for run-of-mine.

The tonnage of run-of-mine, prepared, and screenings for each district is obtained from the cost sheets; then the average division of the screened

coal in percentage is computed and from this margins are determined which will permit screening but not too greatly stimulate the practice. For instance, if a coal will produce 55 per cent. prepared, and 45 per cent. screenings, an equal margin above and below the run-of-mine price would be indicated; but a coal which would produce 30 per cent. prepared and 70 per cent. screenings would need a much larger margin for prepared above run-of-mine, and a very small margin below for screenings.

If the "spread" is not correctly figured, the result is to make some combination unduly profitable, with the result that only that combination is found to be made. In some instances, run-of-mine from particular collieries shows a few cents margin over screened coal, and these collieries will produce run-of-mine exclusively. In other cases, prepared and screenings are more profitable, with the reverse result.

Unusual Sizes

In many parts of the country, it was found that special sizes were customarily made. In Illinois, for instance, a considerable amount of coal is sized, about in accordance with anthracite practice, into egg, stove, nut, pea, and buckwheat, and in certain States so-called "modified run-of-mine," passing through 2, 3, 4, 5, 6, and 8-in. bars is a standard product. These specially prepared and modified run-of-mine sizes cost the operators something extra, and will only be made if the prices received yield a profit over the regular procedure. The Fuel Administration has met this condition by allowing special prices for specially sized coal, and for modified run-of-mine sizes, but all such prices are so calculated as to allow only enough profit on any combination to permit its existence and not enough to encourage the forcing of such size on consumers.

In price fixing of this sort, it is essential to obtain, from several independent and reliable sources, the percentages of the various sizes produced by screening from each coal likely to be used in this way, and carefully balance the costs, losses, and percentages of each size produced, to arrive at a proper price.

It is also necessary to evolve methods of preventing profiteering on special prices. For instance, it was found that after making sizes down to buckwheat from bituminous coal, in some cases the fine screenings, far below the standard mesh of the district, were run into the regular run-of-mine and sold at the run-of-mine price. This was handled by an order allowing a maximum of 30 c. below *screenings price* for any mixture of the fine coal below ½-in. mesh with any other coal. This is easy to police, as the mere report of sizes below the standard screenings mesh of any district involves the report of special fine screenings or "carbon" at the price 30 c. below screenings, and if such is not found, it is assumed to be mixed with commercial sizes.

Margin

The difference between the mine costs, arrived at as above described, and the price is the "margin." This is far from being the profit, as many items of expense necessarily incurred are not included in the mine price. Such are: (*a*) Selling expense. (*b*) Improvements. (*c*) Developments to increase output. (*d*) Excess of capital expenditures over normal costs. (*e*) Contracts at lower than "Government Prices." (*f*) Interest on bonded indebtedness. (*g*) Income taxes. (*h*) Excess-profit taxes. (*i*) Profit on investment.

None of these items is properly included in "cost of production" under normal conditions, but in a war situation it is practically impossible to obtain money to capitalize expenditures for excess improvements, and developments, which would normally be capitalized and properly included in the permitted depreciation, particularly as all such expenditures are made at from two to three times their normal costs; it is a serious question whether the "margin" allowed should not be made large enough to include at least this class of expenditures.

Results of Price Fixing

As our Government has been forced into this untried realm of price control by war conditions, it may be interesting to know the results. These, in general, are available only as applied to the latter months of 1917, before the labor increase, compensated for by the 45-c. general advance in coal prices above referred to. Diagram No. 5 shows the average costs, "bulk lines," and prices fixed for practically all districts in the country, as of August and September, 1917, and covers about 84 per cent. of the total output of bituminous coal for the period stated.

The costs for each district, in the proportion of its output to the total tonnage studied, are shown in full lines; the "bulk lines" are shown by dotted lines; and the prices fixed are indicated by dot-dash lines. The diagram also shows the weighted average costs, "bulk lines," and prices fixed for the tonnage included, and effectively disposes of the widely circulated aspersions of profiteering, of which industry has been so freely accused by people having no knowledge of the facts or willfully misrepresenting them.

The weighted average margin between costs and fixed prices for practically the entire bituminous coal production of the country is but 45.6 c., and between the "bulk line," which represents the higher-cost necessary coal, and the price fixed by the Fuel Administrator of but 26 cents. When it is known that the capital invested per ton of yearly output ranges from $2 to nearly $8, and that the items above noted, which amount to a considerable sum per ton mined, must come out of

this very narrow margin, it is evident that the coal business of the country is not only not on a profiteering basis, but is still on a very narrow margin of profit.

The average cost of the 84 per cent. of the total coal represented for the two months of August and September, 1917, was reported to be \$1.696. The adjustments heretofore described raised this reported cost to \$1.706, a very strong endorsement of the honesty of the reports made by the operators.

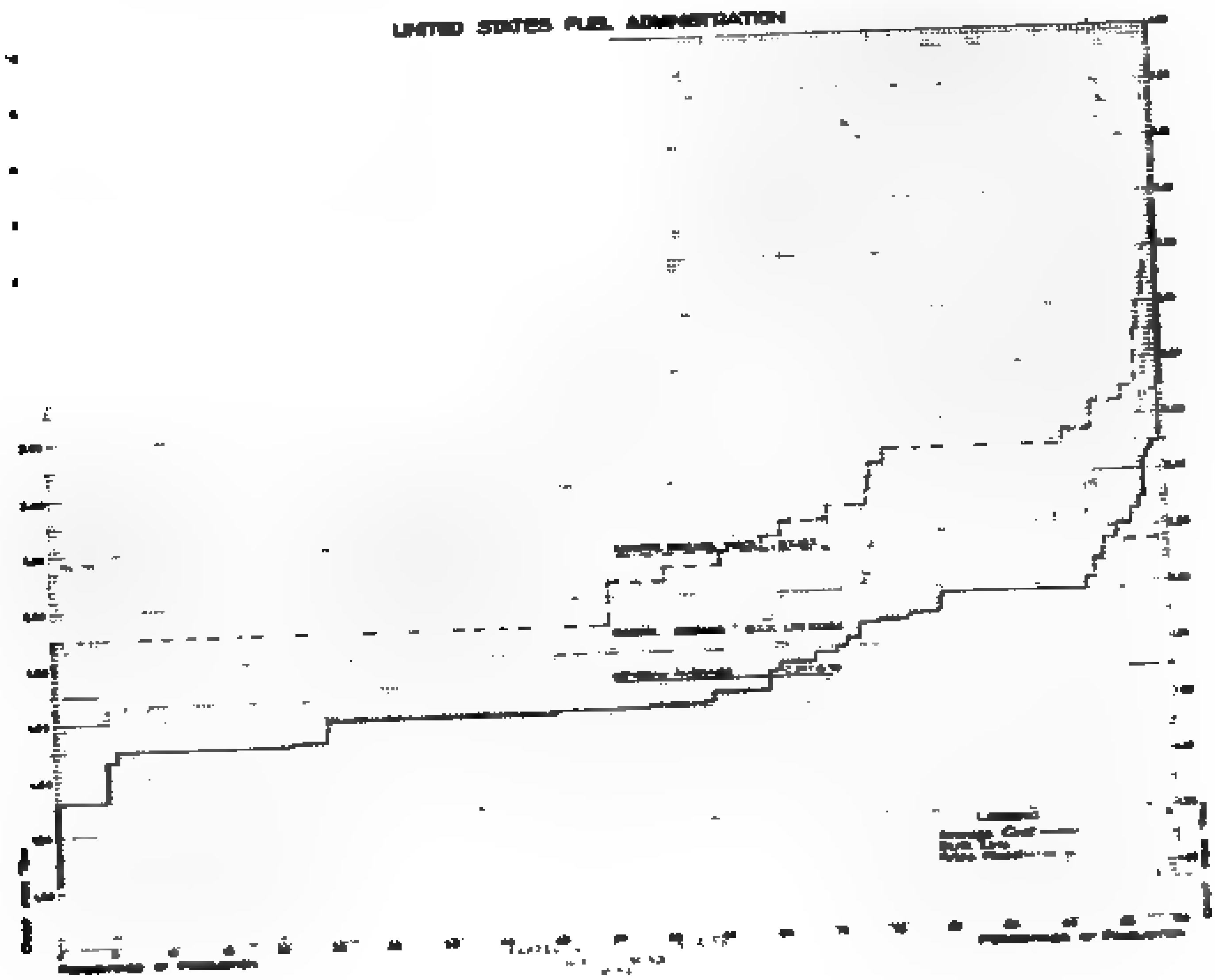


Fig. 5.

The average "bulk line" was fixed at \$1.902, or 19.6 c. above the average adjusted cost. This represents the margin required to assure the mining of the necessary coal, as compared with the average cost, which, of course, involves the mining of only coal up to or below the average cost; in other words, half the available output.

The weighted average of all prices fixed is \$2.162 per ton and the average margin above the "bulk line" is 26 c., representing all the above mentioned charges and all profit for the higher-cost necessary mines; the margin above the average weighted cost for the whole country is 45.6 c. per ton, which, compared with profits in other businesses, certainly does not show any signs of profiteering in the coal

business as a whole. The prices fixed are also sufficient, on the basis of the reported costs, to permit the mining of 98.4 per cent. of all available coal, without loss.

The prices fixed from this complete investigation of costs have shown, in many cases, a remarkable compliance with economic laws. For instance, in Illinois the cost of coal from the different price districts, delivered in Chicago, is found to be practically identical, showing that the mining of the higher-cost coal is due to its proximity to the principal market and the lower resulting transportation costs. High-grade coal shipped by lake and rail to Minneapolis was found to cost precisely the same per heat unit as a lower-grade coal shipped a much less distance all rail.

Special Prices

The price fixing program adopted is expected to take care of all normal mining conditions and to permit the operation, with a reasonable profit, of all mines necessary to the country under war conditions. There are cases, however, of old established mines which are producing coal of a quality specially suited to certain processes or requirements, which coal, while produced at a cost materially above the regional "bulk line," is necessary and has always commanded a special price. In these cases, a higher price, sufficient to permit operation, is usually granted. Also, in some cases, groups of small mines, not required to report, are found to be serving certain communities at prices below other coal available, considering the transportation charges, but with costs above the regional "bulk line." These also receive special prices.

In general, it is the policy of the Fuel Administration to encourage the operators to produce all coal needed and to place restrictions only on coal mined under conditions notably uneconomic.

Effect of Short Time

While it is a syllogism in mining regions that "short time means increased costs," but little actual information as to the quantitative effect of lost time on the cost of coal mining is available. In the discussion as to the advantages or disadvantages of an even car supply to all mines, as compared with 100 per cent. supply to some and the remainder to the others, it devolved upon the Committee to determine, at least approximately, the effect of lost time on the cost of mining.

Fortunately, reports were available from 73 operators in the New River District of West Virginia, which had been made out and submitted by an eminent firm of expert accountants for each month of the year 1917. Each of these was carefully analyzed, and the percentage in-

crease of cost for each of the 830 observations thus obtained was platted; weighted averages were then taken at each 2.5 per cent. from 70 to 100 per cent. working time, and for each 5 per cent. below 80 per cent. The result of this study is submitted on diagram No. 6 which has been checked by numerous observations from practically every field, and has been found, within reasonable limits, to be correct. This diagram can be and has been used in reducing to normal cost the reported costs of collieries shut down during parts of months.

Fig. 6.

Anthracite Prices

Anthracite prices were fixed by the President on Aug. 23, 1917, and have not since been revised. The matter is now a subject of intensive study, and it is expected that after sufficient data have been accumulated a revision and scientific price fixing will be attempted.

The problem of anthracite price fixing presents all the difficulties encountered in the bituminous fields, complicated beyond measure by the varying percentages of sizes produced by different mines in the same region, and the still more widely varying percentage of sizes produced by the different regions.

Conclusion

It should be generally known that the United States Fuel Administration exists only for war conditions. It expires by limitation of the Lever Act.

The Administration is endeavoring most earnestly to give both to the miners and to the consuming public a fair deal and no favor. It has accomplished incredible results in conservation of fuel and stimulation of output, but such results have only been possible by the earnest, whole hearted, and patriotic support freely given by operators, miners, and by the consuming public.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

The Manufacture of Silica Brick*

BY H. LE CHATELIER AND B. BOGITCH

(Milwaukee Meeting, October, 1918)

CONTENTS

1. Introduction

SILICA brick are indispensable in the manufacture of steel because they alone are able to withstand the high temperature of regenerative furnaces. All attempts to replace silica brick by other refractory materials for this

* This paper was submitted to us in manuscript form by M. Le Chatelier, who called our attention to the fact that it had already been published in the *Bulletin de la Société de l'Industrie Minérale*, 3d livraison de 1917, page 49. On account of this previous publication, it has not seemed necessary to reproduce the paper in our *Transactions* in the form of a literal translation, and the editor has therefore not attempted to conform exactly to the language of M. Le Chatelier. The importance of silica brick in the American steel industry and the eminence of M. Le Chatelier in this field, together give ample justification for the reproduction of this paper in the English language.

purpose have failed, but the reason for this failure has remained obscure; we shall give an explanation later in this paper.

Before the war, silica brick employed in France came principally from abroad, for which reason, since the beginning of hostilities, certain French steel works have been seriously handicapped. Our attention was first directed to the question by M. Bied, Engineer of the Teil Works. With him, we began certain investigations, at first using our laboratory and the furnaces of neighboring steel works. The larger part of our experiments, however, have been made in the laboratory of the Faculty of Sciences at the Sorbonne. For the heating of our samples, we are deeply obliged to MM. Charpy, Yeatmann and Guérineau. In undertaking these studies, our first aim has been to render assistance to French industry, by indicating, as precisely as possible, the necessary conditions for the manufacture of high-grade brick; but at the same time we have intended to give an example of the manner in which scientific methods may be put to practical application in the solution of industrial problems. Although our work has been confined to samples of only a few grams, we are nevertheless convinced that our information can be directly utilized by brick works of which the output is measured in thousands of tons

2. Methods of Investigation

As to what are the most important and necessary qualities of silica brick, if one were to ask the steel metallurgists they would almost unanimously reply that there was only one, namely, that the brick should permit the greatest possible number of runs without necessity for repairing the furnace roofs; they might suggest 400 runs as a satisfactory figure. Durability, however, is not the only factor. The brick have to be transported from the factory to the steel works without being injured by the jar or by freezing; many otherwise satisfactory bricks will not satisfy this last condition. It is further necessary that the brick shall not be too expensive, in order not to add unnecessarily to the price of the manufactured steel. The fundamental requirements, therefore, are the following: (1) durability of the furnace; (2) durability in transport; (3) moderate price.

Destruction of Furnace Roofs

Considering first the subject of durability of furnaces, the processes by which furnace roofs are destroyed can be answered by the direct observation of those in charge of furnaces. Our inquiries along this line did not meet with great success; only two steel works, the Ruelle Foundry, and the Chaussade Works, have been able to give us precise information, but unfortunately contradictory. One of these works has assured us that the roofs of Martin furnaces are almost invariably destroyed by

progressive decrepitation under the action of heat. The other works, on the contrary, has assured us that similar furnaces are destroyed almost exclusively by melting. The brick manufacturers, on the other hand, have given us still a third reason, the ignorance or negligence of those in charge of the construction and operation of the furnaces. The engineer may have designed the profile of the furnace badly, not placing his burners in the most desirable place, or applying the first heat of the furnace too abruptly. The builder may have erred in shaping his bricks carelessly and laying them irregularly, so as to produce local pressure sufficient to occasion rupture. Above all, the heat may melt the roof of the best furnace, sometimes in a few hours, if the gas is badly regulated or if the reversals of flame are at too long intervals. From the discussion of this contradictory information and from suggestions found in different foreign publications we have arrived at the provisional conclusion that the destruction of the roofs of steel furnaces may arise from five possible different causes, ranking in the following order of diminishing importance:

1. Superficial spalling of the brick under the influence of the highest temperatures developed in the furnace. This phenomenon is often noticed in the form of a continuous rain of little fragments, the falling of which may, after a few days, lead to the entire disappearance of the brick. This source of destruction depends upon two properties of the brick: Expansion of silica under high temperatures, and lack of mechanical strength at high temperature.

2. Superficial melting of the brick. Brick always melts superficially and continuously under the action of the spattering slag; this normal destruction of brick may continue for several months before leading to an actual cavity in the roof. Often, however, the brick will melt all at once for a considerable width, several centimeters at a time, by which means the normal destruction of the brick may be multiplied by 10 or more. This phenomenon depends upon the fusibility of the brick itself and upon its permeability, which facilitates the absorption of slag.

3. Flaking or shelling of the brick in the less intensely heated region. This begins to occur during the warming of the masonry, and below red temperature, and continues in the more remote parts after the furnace as a whole is considerably hotter. The brick, thus fractured, may then become detached and fall from the roof. This phenomenon is caused by the excessive dilation which is shown by all crystalline silicas at their temperatures of reversible transformation. Quartzose rocks decrepitate at a temperature of about 570°; cristobalite, around 230°, undergoes an abrupt change in dimensions, of very important character; tridymite, finally, at about 150° undergoes a change of slight importance. This tendency to rupture is offset by mechanical resistance of the brick and by its structure, that is to say, by the size of its grain and its amount of porosity.

4. Dislocation of the roof by excessive expansion. In furnaces made of silica brick, the roof always rises more or less when the furnace is first put into operation; this rising often becomes excessive and very irregular from point to point, which then leads to the falling in of the roof. This dislocation results, the same as spalling, from expansion of silica. If the brick is sufficiently resistant, and is heated over a considerable width all at once, it does not spall but causes the roof to rise.

5. Collapse of the roof. The frequency of this accident with clay, magnesia, and alumina brick, makes it impossible to use these materials for the construction of the roofs of furnaces intended to maintain very high temperatures. Collapse will also occur, but very rarely, in furnaces made of silica brick. Collapsing results from the softening that precedes fusion and therefore depends upon the same factors as fusibility. It is very rare in silica brick, being counterbalanced by the expansion of the quartz resulting from its transformation into silica of low density.

The reasons for the destruction of furnace roofs, and the properties of the brick upon which these depend, can now be tabulated as follows:

Causes of Destruction	Properties of Brick
1. Spalling	1. Fusibility
2. Fusion	2. Compressive strength at high temperatures
3. Flaking or shelling	3. Permeability
4. Dislocation of the roof	4. Expansion
5. Collapse	5. Dilation
	6. Compressive strength at ordinary temperatures.

It would be hazardous to assert that this list is absolutely complete, but if any phenomenon has been omitted it is for the engineers of steel works to inform us.

3. The Tridymite Network

It is well known that silica exists under five different allotropic forms, as shown in Table 1.

Table 1.—*Allotropic Forms of Silica*

	Density	Temp. of Transformation, °C.	Abrupt Change in Linear Dimensions, Per Cent.
Quartz	2.65	570	0.25
Cristobalite	2.34	225	1.00
Tridymite	2.27	150	0.10
Chalcedony	2.58	570	0.10
Glass	2.22		

Quartz is the universal raw material for the manufacture of silica brick. Deposits of quartz can be grouped into four distinct classes:

(1) Quartz veins, consisting of large crystals adjoining one another, forming translucent or opalescent white masses. (2) Quartzite (Fig. 3, 4, 5,

Fig. 1. Fig. 2.

Fig. 1.—Carbonaceous sandstone from Sheffield; ganister, used for the manufacture of silica brick. Dissemination of mica between the quartz grains. Natural light, magnification, × 136.

Fig. 2.—Same sample as Fig. 1, under polarized light.

and 6), metamorphic rock in which the grains of quartz are so strongly cemented together that upon breaking the rock the fractures traverse

Fig. 3. Fig. 4.

Fig. 3.—Souvigny quartzite, with dull fracture. Material of first quality. Polarized light; magnification, × 136.

Fig. 4.—Souvigny quartzite, with ribbon structure Material of second quality. Chalcedony concretions about the quartz grains. Polarized light; magnification, × 136.

the grains of quartz rather than their boundaries. Quartzite contains impurities in variable proportion, sometimes lodged between the grains,

like mica, sometimes included in the quartz crystals themselves, as oxide of iron, for example. (3) Sandstone (Fig. 1 and 2), the grains of which are combined by a cement having but little resistance, in which fracture occurs by the separation of the grains, giving a dull luster to the fractured surface. (4) Sand, the grains of which are separated. The purity of sand is very variable; that of Fontainebleau analyses 99.5 per cent. silica; after this come the yellow argillaceous sands, and finally sandy clays. An important character of sand is the uniformity in size and shape of its grains, which are objectionable features for the manufacture of brick.

Most factories employ quartzite containing not more than 3 per cent. of basic oxides, and mix with it 2 per cent. of lime. The crushing of the

FIG. 5. FIG. 6.

FIG. 5.—QUARTZITE CONTAINING CHALCEDONY. THIS DISINTEGRATES ON FIRING AND CANNOT BE USED FOR THE MANUFACTURE OF SILICA BRICK. POLARIZED LIGHT; MAGNIFICATION, × 136.

FIG. 6.—QUARTZITE WITH DEFORMED GRAINS, CEMENTED BY OPAL OR CHALCEDONY. UNDESIRABLE FOR THE MANUFACTURE OF SILICA BRICK. POLARIZED LIGHT; MAGNIFICATION, × 136.

rock is conducted in such manner as to preserve a number of large grains, having a maximum size of between 5 and 10 mm. The firing is performed at a high temperature, much above that employed in the manufacture of clay brick, and is maintained for a much longer period. This temperature may vary from 1350° to 1450° according to the nature of the quartz and the ease of its transformation.

Firing progressively reduces the density of the silica; quartz transforms first into cristobalite and finally into tridymite, as one of us has shown 25 years ago. These are the basic facts upon which our researches were conducted.

Compressive Strength of Refractory Products

Before attacking the problem of the manufacture of silica brick, we have sought to answer an allied problem: Is it possible to find certain

measurable properties of refractory products which will explain the superiority of silica over clay, alumina, and magnesia? An exact knowledge of the reason for the superiority of silica brick would certainly be a valuable guide to determine what properties are the most important to develop in the manufacture of refractory materials. One difficulty in explaining the superiority of silica brick has been that in previous experiments it has been noted that the melting point of silica brick was not higher than that of other refractory products. Kaolinite melts at 1800°, the same as silica; alumina and magnesia melt at much higher temperatures. These latter materials should, therefore, afford brick at least as good and perhaps better than quartz. Instead of determining simply the melting point, as has often been done before, that is to say, the temperature at which the material yields under a pressure of only a few grams per centimeter, we decided to measure the compressive resistance of these materials throughout the whole field of temperature.

The experiments were made in a small furnace, heated by a blast of illuminating gas. The furnace, having an interior capacity of 500 c.c., gave a temperature of 1600° at the end of half an hour, with a gas consumption of 3 cu.m. per hour. The walls of the furnace were made of corindite (melted bauxite) cemented with a little sodium silicate; this material seemed to resist the action of heat indefinitely provided it was not required to support any load. The samples to be tested were in the form of little cubes, 1 cm. on a side, cut out of the bricks to be studied. Pressure was transmitted to them through a bauxite cylinder previously heated to a temperature of 1600°, penetrating the roof of the furnace. The temperature was measured by a thermo-electric couple attached to the sample. The results were as shown in Table 2.

TABLE 2.—*Crushing Strength of Bricks at Different Temperatures*
(Pressures in kg. per sq. cm.; temperatures in ° C.)

	15°	500°	1000°	1300°	1400°	1500°	1600°
Silica (Star brand)	170	150	120	75	60	48	30
Kaolin	190	180	210	90	(12)	(1)	(0.5)
Eubœan magnesia	420	380	320	270	240	(185)	(8)
Styrian magnesia	145	130	85	66	(5)	(3)	(1)

It is thus apparent that at 1600°, which is still 100° below the temperature of the Siemens-Martin furnace, silica brick has a compressive strength very much higher than that of the other refractory products. Furthermore, a factor which is of no less importance, the silica brick broke abruptly at all temperatures; they did not register any progressive deformation before rupture. With clay and magnesia brick, on the other hand, the observations were entirely different. At temperatures below

1000° they broke abruptly like rigid bodies, but at higher temperatures, above a limit varying according to the purity of the material, the brick yielded little by little, like plastic matter. If, instead of making these oests in about one minute's time, as in our investigations, the application tf the force had been prolonged for 1,000,000 times longer, as occurs in the roofs of furnaces, the brick would have yielded under pressures

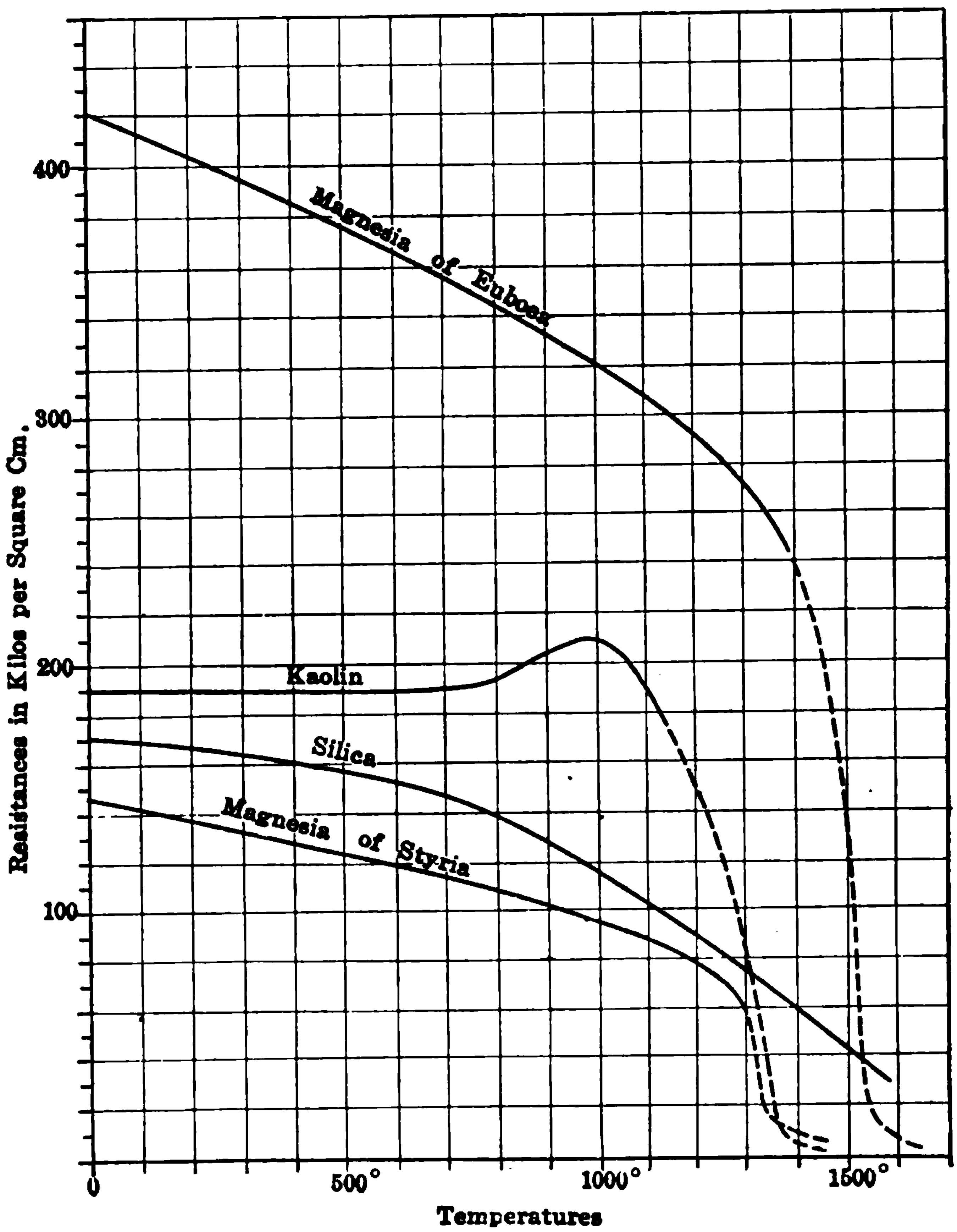


Plate I.—Variation in the crushing strength of refractory products at different temperatures.

so small as to be practically negligible, having somewhat the character of rosin at ordinary temperature. In order to rupture such materials abruptly, an impact is necessary; left to themselves, they yield under their own weight and spread out level like a liquid.

The transformation from complete solidity to complete viscosity is obviously progressive. Within a certain range of temperature, an initial deformation is followed by a true rupture. Complete viscosity is definitely attained above the following temperatures:

Silica brick	1700°
Euboean magnesia	1500°
Styrian magnesia	1300°
Kaolin brick	1300°
Ordinary refractory brick	1200°

It is very easy, in the test, to distinguish between these two methods of rupture. In the case of complete solidity, the sample breaks abruptly and the whole compression apparatus comes together with a jar. In the case of viscosity, the beam of the pressure machine falls progressively and continuously. The sample is first compressed upon itself, by the closing of its spaces, then it expands in the form of a barrel, then bursts on its periphery, and finishes by breaking or not, according to its solidity. In the intermediate stage between solidity and complete viscosity, the two methods of deformation can be successively observed. The sample first yields progressively, then breaks more or less abruptly, throwing out fragments. The remaining mass has no further solidity; on the contrary, the fragments thrown out by the bursting of completely viscous material resume their original solidity after cooling.

Recrystallization of Silica

This ability of silica brick to preserve their rigidity at the very highest temperatures explains their superiority for furnace manufacture. As a means of reducing this factor to its simplest terms, we began with an examination, under polarized light, of thin sections cut from bricks of good quality, one marked "American Star" and the other marked "Imphy," these being the two bricks which showed the highest compressive resistance at 1600°, namely 30 and 40 kg. per sq. cm. They were composed of large, easily recognizable grains of the original siliceous rock, completely transformed into cristobalite and surrounded by a magma formed of little elongated crystals of tridymite (Fig. 7). The rigidity of the brick is evidently due to the crystallization of tridymite, which forms a continuous network, in the meshes of which the fusible silicates are lodged. The presence of these latter materials does not detract from the solidity of the mass any more than water in the cells of pumice stone would diminish its strength; in both cases the solid network is unbroken.

In magnesia brick, on the contrary, and also in clay brick, at least in those manufactured under ordinary conditions, this recrystallization does not occur. The slightly fusible material, magnesia, forms isolated grains which are surrounded, at ordinary temperatures, by a magma of very solid silicates; the latter, however, melt at around 1300°, if ferruginous, or at about 1500° if purely magnesian. Above these temperatures, therefore, the solid grains swim in a melted mass and can slide on one another; the more fluid the magma, the more readily they slide.

The formation of this continuous network of silica is exactly parallel to the phenomenon observed in the hardening of cement. A mixture originally consisting of isolated grains, when tempered with water, is progressively transformed by chemical reaction into a coherent mass. In the same manner, the isolated grains of quartz in a brick become set on contact with melted silicates, which operate as solvent.

Quartz is unstable at temperatures above 800°, but owing to its remarkable passive resistance, it is able to remain for a long time in that condition at very high temperatures, even up to 1600°. If it is then brought into contact with a solvent, melted silicates for example, it dissolves in that with a readiness very much greater than that of the more stable forms of silica, cristobalite and tridymite. This is due to the unanswerable and thoroughly established laws of physical chemistry. The quartz thus gives rise to supersaturated solution, from which one of the more stable varieties soon begins to crystallize. The melted mass, now being no longer saturated with respect to quartz, is able to dissolve additional quantities of it. Gradually, therefore, the entire amount of quartz recrystallizes into the variety that is most stable at high temperatures, tridymite. In practice, if the firing of silica brick has not been sufficiently long, the proportion of cristobalite, and sometimes even of quartz, is greater than that of tridymite in the finished product, if of poor grade. Burning for almost a month at the highest temperature of the steel furnace is necessary to transform silica completely into tridymite. The

Fig. 7. Fig. 8.

Fig. 7.—Well fired American brick, with network of tridymite between the quartz grains, which are almost completely transformed into cristobalite. Polarized light; magnification, × 136.

Fig. 8.—Assailly brick, remaining for a year in one of the flues of a Martin furnace. Complete transformation into coarse-grained tridymite, with characteristic inclusions. Polarized light; magnification, × 136.

crystals of tridymite thus formed by solution attach themselves to one another, as is always the case under similar conditions, and form the network above mentioned.

Quality of the Brick

This explanation for the superiority of silica brick gave rise to the question whether variations in quality were not exactly parallel to the compressive strength at high temperatures. To settle this question, we requested, from different steel works, samples of brick which had been used for the construction of furnaces, as to the relative quality of which

FIG. 9. FIG. 10.

FIG. 9.—TRIDYMITE CRYSTALS SURROUNDED BY A SOLUTION OF MAGMA. BRICK OBTAINED ON DISMANTLING THE ROOF OF A MARTIN FURNACE. COLUMNAR CRYSTALS AND RECTILINEAR CLEAVAGES CHARACTERISTIC OF TRIDYMITE. NATURAL LIGHT; MAGNIFICATION, × 136.

FIG. 10.—CRISTOBALITE CRYSTALS SUBMERGED IN A TRANSPARENT GLASS. MATERIAL DERIVED FROM RELINING OF A BESSEMER CONVERTER AT SHEFFIELD. CIRCULAR CLEAVAGES CHARACTERISTIC OF CRISTOBALITE. NATURAL LIGHT; MAGNIFICATION, × 136.

they were able to advise us. The Ruelle and the Guérigny Works sent us well classified series of samples upon which we made tests giving the results shown in Table 3. The tests on compressive strength at high temperatures were made, with some samples as soon as 1600° had been reached, while with other samples only after they had been maintained at this temperature for one hour. We realized that these two methods of proceeding might give different results in some cases. At the same time, we made determinations of a number of other physical properties, such as absolute density, apparent density, weight of sulphate corresponding to basic oxides present, and finally compressive resistance at ordinary temperatures.

TABLE 3.—*Features of Certain Silica Bricks*

Mark	Quality	Sulphates, Per Cent.	Density		Crushing Strength		
			Absolute	Apparent	Temp., ° C.	Time, Min.	Kg. per Sq. Cm.
Assailly	Very good	13.6	2.30	1.92	15	..	550
Assailly	Very good	....	....	....	1600	60	90
Star	Very good	9.06	2.33	1.66	15	..	170
Star	....	....	....	....	1600	5	33
Star	....	....	....	....	1600	60	30
G.I	Very good	8.40	2.33	1.88	15	..	185
G.I	....	....	....	....	1600	60	41
R.B	Very good	13.10	2.35	1.60	15	..	62
R.B	....	....	....	....	1600	60	9.5
R.L	Very good	14.3	2.40	1.85	15	..	265
R.L	....	....	....	....	1600	5	41
R.L	....	....	....	....	1600	60	25
G.A	Good	14.0	2.40	1.77	15	..	190
G.A	....	....	....	....	1600	60	21
D	Good	8.4	2.45	1.73	15	..	320
D	....	....	....	....	1600	5	55
D	....	....	....	....	1600	60	20
G.A.1	Very bad	14.5	2.46	1.80	15	..	252
G.A.1	....	....	....	....	1600	60	4.4
R.F	Very good	13.7	2.48	1.84	15	..	195
R.F	....	....	....	....	1600	..	11
G.A.2	Very bad	12.8	2.48	1.78	15	..	148
G.A.2	....	....	....	....	1600	60	5
G.M	Medium	9.5	2.53	1.84	15	..	84
G.M	....	....	....	....	1600	5	17
G.M	....	....	....	....	1600	60	2
R.L	Bad	9.75	2.56	1.94	15	..	350
R.L	Shatters	....	....	....	1600	5	18
R.L	....	....	....	....	1600	60	4.5
R.S.G	Bad	25.0	2.56	1.73	15	..	57
R.S.G	(melted)	....	....	....	1550	60	22
R.S.G	....	....	....	....	1660	Melted	

The first brick, Assailly, had remained a year in the lining of the outlet from a gas producer. The next two bricks, American Star, and G. I., of French manufacture, were recommended to us as of particularly good quality. The last brick in the Table, RSG, it has not been possible to use, a roof constructed with these bricks having melted on the first application of heat. The other bricks were of French, English, and German manufacture.

All of the good bricks, after being held at 1600° for one hour, showed a compressive strength greater than 10 kg. per sq. cm.; most of the good bricks exceeded 20 kg., while the poor bricks were below 5 kg. It seems evident, therefore, that rigidity at high temperatures is the most essential

if not the only important quality of silica brick. Most of the good bricks have densities below 2.40, the very good ones being as low as 2.33. The amount of sulphate in good bricks is below 15 per cent.

4. Independent Variables

Table 4 enumerates the essential properties of silica brick, together with the elementary factors to which they are more or less directly related:

Table 4

Properties of Brick	Elementary Factors
1. Fusibility	1. Nature of quartz
2. Compressive strength at high temperature	2. Size of particles
	3. Nature of fluxes
3. Permeability	4. Proportion of fluxes
4. Expansion	5. Thoroughness of mixing
5. Dilation	6. Tempering water
6. Compressive strength at ordinary temperature	7. Pressure of molding
	8. Temperature of heating
	9. Duration of heating

Fusibility

Fusibility depends, in the first place, upon the presence of basic oxides mixed with the quartz. Secondly, which may appear somewhat paradoxical, fusibility depends upon the conditions of manufacture; certain foreign manufacturers go so far as to assert that fusibility depends much more on the texture of the brick and their manner of firing than on their chemical composition.

The quartz employed for silica brick is almost never pure, generally containing mica; furthermore, the crushing of the quartz always introduces a certain proportion of iron. The average composition of silica, crushed and ready for use, is as follows: Alumina, 1.5; oxide of iron, 1.0; magnesia and alkalies, 0.5; silica, 97 per cent. As a binder, lime to the extent of 2 per cent. is always added, thus making a total of 5 per cent. of basic oxides. If this is computed to the condition of sulphate, after attack by hydrofluoric acid, it represents a total of 12 per cent. of sulphate; bricks containing above 15 per cent. of sulphate are useless for steel furnaces, and, in general, good bricks should not contain more than the equivalent of 10 per cent. sulphate.

The influence of the different basic oxides on increase of fusibility should not be exactly alike, but on this point our studies have not been conclusive. Oxide of iron seems to have the least influence, since silicates of iron are decomposed at high temperatures; alumina comes next, then lime, and finally alkali, the action of which, even in a small proportion, appears to be very energetic.

The effect of the method of manufacture upon the fusibility of the brick is unquestionable. Bricks having a perfectly normal chemical composition are often found to fuse at the temperature of steel furnaces, giving rise to a granular mass in which the large grains of silica are mobile. This arises from the absence of a sufficient amount of fine material in the mixture, and from a firing not sufficiently complete to permit the development of a proper network of tridymite. On further heating, the network disappears by solution in the magma, leaving between the large grains a glass which is less siliceous and more fusible in proportion to the absence of fine grains. The examination of thin sections of brick shows very clearly that the grains of silica are attacked by the magma only to a depth of 0.01 to 0.02 mm. Only grains of 0.03 mm. or less dissolve completely in the magma and contribute to the formation of the network. Assuming that the amount of grains of this size is only 10 per cent. of the total and that 2 per cent. of lime is added; this would represent 20 per cent. of the weight of the fine grains and would give a fusible glass in which the large grains would swim. According to our investigations, the proportion of impalpable material, that is to say, of quartz passing through a screen of 4900 openings per sq. cm. (approximately 200-mesh), should be at least 25 per cent. Adopting that proportion, at the very first test we obtained a compressive strength of 30 kg. per sq. cm. after heating for one hour at 1600°, which is comparable to the strength of the best commercial brick.

Shelling or Rupturing

Shelling or rupturing of brick at low temperatures, which occurs on the external surface of brick at the beginning of heating, but may penetrate half way through the brick toward the end of the heating, arises principally from the change in volume which the different varieties of silica undergo during their reversible transformation. The transformation of cristobalite, accompanied by a linear expansion of 1 per cent., is by far the most serious. Every time a brick containing a large proportion of cristobalite passes quickly through the temperature of 225°, crevices are produced, which diminish the rigidity of the brick. According to the experiments of J. Spotts MacDowell,[1] a single heating to above this temperature, followed by cooling in the air, reduces the compressive strength of silica brick by 50 per cent. For this reason, it is impossible to utilize silica brick in furnaces which will be allowed to cool periodically; under such conditions, the brick will become fissured and almost completely disintegrated in a short time. In steel furnaces maintained under constant heat, this accident is most likely to occur during the period of preliminary heating.

[1] *Trans.* (1917), **57**, 3–59 (contains bibliography).

This disadvantage of silica brick is offset by their mechanical strength, opposing the production of crevices, by the presence of large grains of quartz, the large spaces between which prevent the spreading of the crevices, but, above all, by as complete a transformation as possible of cristobalite into tridymite.

A very striking experiment, which can be strongly recommended to all steel-works engineers, consists in placing a silica brick in a small gas furnace, or a kitchen stove, and regulating the heat in such a manner that the lower surface of the brick is raised to an incipient red in 5 min.; after maintaining the heat for a quarter of an hour, the brick is taken from the fire and allowed to cool for the same length of time. After this treatment, fragments can be broken off from the brick by hand, and the same operation can be repeated. In the case of a brick having absolute density of about 2.35, the brick will have been entirely disintegrated at the end of the fifth operation.

On the other hand, a slow and regular heating of the brick prevents this disintegration by diminishing the temperature gradient toward the interior of the brick. We have been able to avoid all fissuring with a brick which fractured easily, under the above treatment, by heating it to 500° at the rate of 50° per hour, and allowing it to cool at the same rate.

Wood fires, which are frequently employed for starting the operation of a steel furnace, are particularly dangerous by reason of the irregularity of their heating effect, regions of high temperature necessarily occurring above the points at which combustion is most active. It would be desirable to avoid wood fires at steel works, as has been done at glass works, by using currents of hot air with progressively increasing temperatures.

Expansion

Expansion, leading to the superficial spalling of brick and warping of roofs at high temperatures, is a function of the following factors:

1. Change in the condition of silica from that of quartz to a material of less density.
2. Mechanical strength of the brick, opposing expansion.
3. Porosity of the brick, permitting expansion to accommodate itself in the spaces between grains.
4. Rate of increase of temperature during heating. Abrupt heating may produce expansion three to six times as great as a slow heating, such as is maintained in well conducted kilns.

When the change from quartz to tridymite occurs in a massive unfractured block, it causes a linear expansion of about 5.5 per cent. However, by a sufficiently slow firing, the apparent expansion can be reduced to 2 per cent., that is to say, a value below that of absolute expansion. This is accompanied by a parallel diminution in the volume of voids On the other hand, if the heating during the first firing is too abrupt, and

still more if, after an insufficient firing, the transformation is concluded only in the steel furnace, the linear expansion may reach 10 per cent.; there would then be a considerable increase of porosity, rather than a reduction. The brick would become both less strong physically and also more permeable to slag, to say nothing of the ruptures produced directly by the expansion.

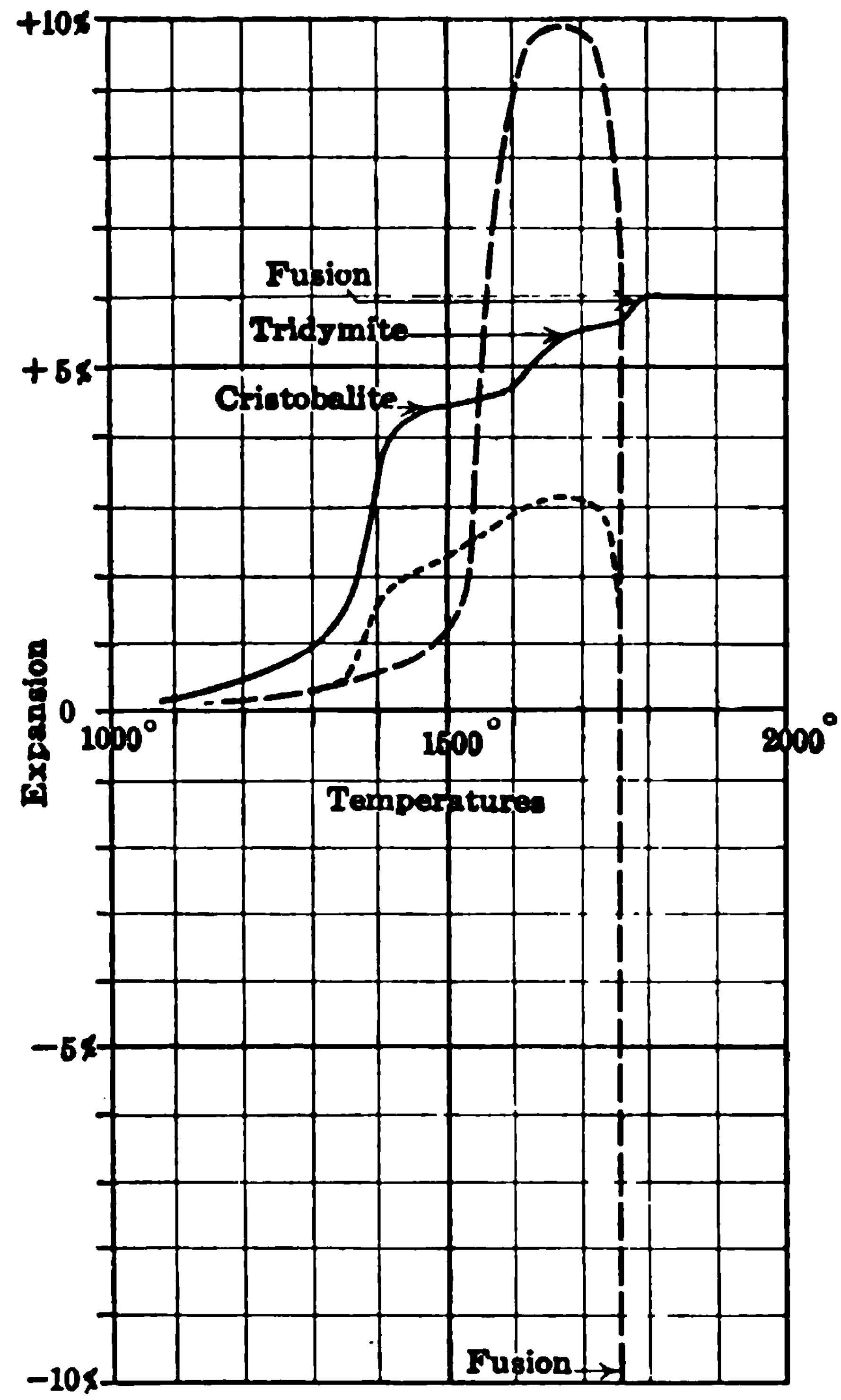


PLATE II.—EXPANSION OF SILICA BRICK UNDER VARYING CONDITIONS.

In the accompanying diagram (Plate II), the solid line represents the theoretical linear expansion of a compact mass. The dotted line shows the normal expansion of a well fired brick not introduced into the steel furnace until after the transformation of the quartz; in this case, one should expect a minimum expansion of 2 per cent. in the kiln, and of 1 per cent. in the steel furnace. The broken lines represent the expansion of a badly fired brick inserted prematurely and abruptly into a steel furnace.

Transformation of Quartz

The expansion of brick, which is intimately related to the transformations of quartz, is of the greatest importance from the point of view of the manufacture of silica brick, and of their use in steel furnaces. Our experiments on this subject have not offered so complete a solution of the problem as we could have desired.

Days' experiments[2] have shown that quartz ceases to be stable above 800°. Its enormous passive resistance, however, opposes this transformation and retards it to such an extent that after heating to 1600°, for only a short time it is true, fragments of unaltered quartz can often be found. In order to produce transformation below 800°, it is necessary to apply some special solvent, such as vanadate of sodium, and to prolong the action of the heat for several days.

In the manufacture of silica brick, the transformation of quartz occurs in three different ways:

1. By solution and recrystallization in the melted silicates. This phenomenon begins at the melting point of these compounds, around 1200°, and proceeds with rapidity in proportion to the temperature. It is this reaction that produces the network of tridymite referred to above.

2. By direct transformation of quartz fragments without any other agencies than temperature and the presence of natural impurities in the rock. This transformation takes place at variable temperatures in quartz from different localities; the exact reason for the variation is not understood. Silex can be transformed in less than an hour at 1300°; the Fontainebleau sand, which is very pure, transforms at 1500°; the impure quartzite ordinarily used for the manufacture of brick transforms at temperatures between these two limits.

3. By direct transformation of the quartz under the influence of foreign bodies which seem to penetrate by diffusion to a certain depth into the grain. Cristobalite, according to some investigators, would be particularly likely to give rise to these solid solutions.

One of us has shown, 25 years ago, that crystals of very pure quartz can be put through a furnace for the production of hard porcelain, without undergoing any transformation. Under the same conditions, the same quartz finely pulverized is completely transformed into silica of low density. In the same manner, in the manufacture of fine faience, the more finely the quartz is pulverized, the more complete is its transformation. This influence of grain size cannot be explained except on the assumption of a superficial action from vapors in the atmosphere of the furnace, whether steam, or alkali vapors derived from other elements in the ceramic mixture, notably feldspar.

We have made several tests on the transformation conditions of quartz, and have studied successively the influence of the following factors:

1. Nature of the quartz.
2. Size of the fragments.
3. Nature of the flux.
4. Proportion of flux.
5. Length of firing.
6. Temperature of firing.

---

[2] *American Journal of Science*, ser. 4 (1914), **37**, 1–39.

The tests were made in a Bigot furnace, the several samples being heated simultaneously. Except for the last experiment, regarding the influence of temperature, the heating was always conducted in such manner as to raise the temperature to 1400° in 1½ hr., after which this temperature was maintained for 1 hour.

1. *Nature of the Quartz.*—In these tests, the quartz was introduced in fragments as large as hazel nuts, but most of the fragments decrepitated in the furnace. The density of the samples after firing is shown in Table 5.

TABLE 5.—*Effect of Nature of Quartz on Ultimate Density*

Source of Quartz	Density after Heating
Pebbles from Central Plateau	2.65
Bouchard quartzite	2.62
Souvigny quartzite (very pure)	2.60
Urçay quartz	2.36
Plat quartz	2.35
Souvigny quartzite (very impure)	2.32
Silex	2.30

2. *Size of the Fragments.*—These tests were conducted with the two varieties of quartz which were found the most difficult to transform. Results are given in Table 6.

TABLE 6.—*Effect of Size of Particles on Ultimate Density*

	Pebbles from Central Plateau. Final Density	Allier Quartz (Very Pure). Final Density
Larger pieces	2.65	2.60
Between 80 and 200 mesh*	2.64	2.57
Below 200 mesh	2.59	2.39

3. *Nature of the Flux.*—These, and all the following tests, were made on pulverized quartz retained between screens having 800 and 4900 openings per sq. cm. (approximately 80 and 200 mesh per linear inch). The temperature, as before, was maintained at 1400° for 1 hour. In each case, the amount of flux added was 3 per cent.; the quartz was Fontainebleau sand. The effect of different fluxes on the final density of the quartz is shown in Table 7.

TABLE 7.—*Effect on Ultimate Density of Adding* 3 *Per Cent. Flux to Fontainebleau Sand*

Flux	Final Density	Flux	Final Density	Flux	Final Density
None	2.60	Li_2CO_3	2.30	TiO_2	2.56
Na_2CO_3	2.40	CaO	2.53	B_2O_3	2.49
Na_2SiO_3	2.34	Al_2O_3	2.60	CaF_2	2.51
NaCl	2.45	Fe_2O_3	2.58	$BaCl_2$	2.53
Glass	2.32	Pb_3O_4	2.49	ZnO	2.60

4. *Influence of Proportion of Flux.*—The effect of varying the proportion of two fluxes, silicate of sodium, and lime, is shown in Table 8.

* Between 800 and 4900 holes per square centimeter.

TABLE 8.—*Effect on Ultimate Density of Varying Proportions of Flux*

Sodium Silicate Flux		Lime Flux	
Per Cent.	Final Density	Per Cent.	Final Density
0.0	2.60	0	2.60
0.5	2.52	3	2.53
1.5	2.45	6	2.46
3.0	2.34		

5. *Influence of Temperature.*—In these experiments, the heating occupied 1½ hr., the temperature then being maintained at 1400° for 1 hr. or for 3 hours. The results are given in Table 9.

TABLE 9.—*Influence of Time of Heating on Density of Quartz*

Ingredients	Time of Heating	Final Density
Sand alone	1 hr.	2.60
Sand alone	3 hr.	2.51
Sand and 3% CaO	1 hr.	2.53
Sand and 3% CaO	3 hr.	2.46
Sand and 3% NaCl	1 hr.	2.51
Sand and 3% NaCl	3 hr.	2.38

6. *Temperature of Heating.*—In these tests, the sand was heated alone, or with the addition of 3 per cent. of fluxing material, to temperatures of 1300°, 1400°, and 1500°. The results are shown in Table 10.

TABLE 10.—*Effect of Temperature on Density of Quartz*

	1300° C.	1400° C.	1500° C.
	Density	Density	Density
Sand alone	2.65	2.60	2.44
Sand and 3% Na_2SiO_3	2.31	2.34	2.32
Sand and 3% CaF_2	2.56	2.51	2.35
Sand and 3% $CaCl_2$	2.54	2.51	2.35
Sand and 3% Pb_3O_4	2.53	2.49	2.37

It is reasonable to suppose that the natural impurities of quartzites might explain their relative ease of transformation; chemical analyses, however, have not provided any clear indication. The most frequent impurities are mica, interspersed between the grains, and oxide of iron as very finely divided inclusions in the crystals. The addition of calcium fluoride does not seem to have produced any very energetic reaction. Possibly inclusions of water or of carbon dioxide in certain quartz crystals may exert some influence.

The most obvious conclusion seems to be that quartzites containing chalcedony are transformed at the lowest temperatures. Often, however, when the proportion of this variety of silica is large, the mass falls to powder during calcination and is unable to yield substantial brick.

5. Manufacturing Operations

To assist in ascertaining the method of manufacture that will yield the best brick, Table 11 will indicate the lines of relationship.

Table 11.—*Essential Conditions and Steps in Manufacture*

Conditions	Processes
1. Nature of quartz	1. Selection of quartz
2. Size and shape of grains	2. Preliminary calcination
3. Nature of fluxes	3. Crushing
4. Proportion of fluxes	4. Addition of fluxes
5. Tempering water	5. Wetting the mixture
6. Uniformity of mixture	6. Mixing
7. Compression of mixture	7. Molding
8. Temperature of firing	8. Drying
9. Duration of firing	9. Firing

Selection of the Quartz

1. *Degree of Purity.*—The proportion of basic oxides should not exceed 3 per cent., which is equivalent to 10 per cent. of sulphate, if excessive fusibility is to be avoided. On the other hand, the percentage of impurity should not be below 1.5 per cent. to avoid the necessity for excessively high temperatures in order to cause complete transformation of quartz. An average of 2 per cent. of basic oxides represents good practice throughout the world. The proportion of basic oxides in a number of natural materials used for silica brick is shown in Table 12.

There may be some doubt as to the correctness of this opinion. It is certain that a very pure quartz, mixed with an equally pure lime, does not lend itself well to the manufacture of silica brick, their temperature of firing being below the melting points of the most fusible silicates of lime. On adding iron and alumina to the mixture, which occur naturally in impure quartz, satisfactory results may be obtained. A sufficient quantity of iron is often added by the wear of the crushing apparatus itself. It may be questioned whether brick made with the more difficultly transformed quartz, which are also the most expensive to make, are actually the best product. The high temperature, necessary for firing, at the same time facilitates the transformation of cristobalite into tridymite.

Table 12.—*Percentage of Basic Oxides in Certain Siliceous Materials*

	Al_2O_3	Fe_2O_3	Others	Total
Dinas quartzite	1.60	0.30	0.40	2.30
Sheffield black ganister	0.30	1.50	0.20	2.00
German quartzite (Stella)	1.50	0.50	0.50	2.50
Souvigny quartzite (Allier)	0.60	1.55	0.40	2.55

2. *Absence of Pulverization During Firing.*—Certain quartzes fall to powder during calcination and naturally cannot yield other than very

ordinary brick; the large grains, the importance of which has been noted above, disappear during this operation. This fault is easily detected by a rapid heating to between 1500° and 1600°, sufficient to cause transformation of the quartz into silica of low density. This defect often appears to be due to the presence of chalcedony, sometimes accompanied by opal. This last form of silica is difficult to distinguish under the microscope, but its presence can always be recognized by the loss of weight during calcination. It is always advisable, before using a new quartz on a large scale, to subject it to a preliminary calcination at high temperature in order to determine its behavior.

3. *Hardness of the Rock.*—Rocks of great hardness increase the expense of crushing; while, on the other hand, a rock that is too soft makes it difficult to obtain large grains, and especially those of angular shape. For this reason, true quartzites are generally preferred to sandstone, although the latter can be crushed more cheaply. In England, however, the Sheffield ganister, which has a very high reputation for the manufacture of silica brick, is a true sandstone.

Sands are the worst of all natural quartz materials for this purpose, on account of the fineness, the rounded outline, and especially the uniformity in size of their grains. The Fontainebleau sand, for example, contains only grains ranging between 0.1 and 0.3 mm. Sand can well be used, however, for the preparation of the impalpable material, the necessity for which has been indicated above. It would seem possible, nevertheless, to employ it in larger proportions for the manufacture of silica brick. We made briquets containing 75 per cent. Fontainebleau sand, 25 per cent. of impalpable, and 2 per cent. lime; this mixture, after burning at a temperature a little higher than the average, gave a product having an absolute density of 2.32, that is to say, the quartz has been entirely transformed into silica of low density. Compressive strength at ordinary temperatures was 112 kg. per sq. cm., which is ample, and expansion during firing had been 3 per cent., which is a normal amount, but these bricks disintegrated completely at high temperatures on account of the absence of large grains.

4. *Ease of Transformation of Quartz.*—The different varieties of quartz are transformed with varying ease under the application of heat. For example, quartz broken into grains of less than 1 mm. diameter, but remaining on a 200-mesh screen (4900 meshes per sq. cm.), is reduced to a density below 2.40 after 1 hr. of firing, at the following temperatures: Silex, 1300°; ribbon quartzite from Allier, 1400°; pure vein quartz, 1500°.

It is not yet possible to say which is the best. It seems well established that silex always yields poor brick; they are light, very porous, and lack rigidity. The expansion of the largest grains is accomplished before fusion of the flux, and therefore before the formation of the

tridymite network. Those varieties of quartz which are most difficult to transform seem to yield the best products, provided the firing is continued long enough to give a complete transformation of the quartz; this high temperature tends to develop the production of tridymite and diminish that of cristobalite. Abundance of cristobalite is the principal cause of fracture, a very serious defect. At present, the preference is generally for quartz which transforms with moderate ease, yielding sufficiently satisfactory products at a moderate cost.

Calcination of Quartz

A preliminary calcination of quartz, now rarely employed, can be given for two different purposes. The first object is simply to weaken the quartz in order to facilitate its crushing. For this purpose a temperature of around 1000° is sufficient, which can be obtained with a moderate expenditure of fuel. Except in the case of very pure hard quartz, this operation seems to have little advantage, the expense of the firing exceeding the economy realized during crushing. Furthermore, quartz weakened in this manner gives rise to rounded fragments; and this practice is tending to disappear.

In the second place, calcination at very high temperature may be adopted in order to produce a transformation of the quartz before it is introduced into the brick-making mixture. This necessitates a large comsumption of fuel and complicated heating furnaces. It is essential to perform the heating with gas or with a flame, avoiding direct contact of ashes, in order not to discolor the calcined material. A possible application of this method would be to subject the largest grains of quartz to a partial transformation before introducing them into the brick mixture; this would undoubtedly permit a reduction in temperature and in duration of the firing of the brick.

Crushing

The crushing of quartz is always an expensive operation on account of the hardness of the material; it requires the expenditure of considerable energy and leads to a rapid wear of the crushing apparatus. Roller mills are most commonly applied, the operation being continued until the desired degree of fineness is obtained. This does not seem a rational method, because the relative proportion of the different sizes of material cannot be accurately regulated.

The necessity for a large proportion of impalpable material is one of the clearest results of our experiments, some of which are shown in Table 13. On comparing the results of the first two experiments, for example, one mixture containing 25 per cent. of impalpable obtained in a tube-mill, the other containing 25 per cent. of fine material obtained by screening an ordinary crushed product, it is seen that the compressive strength

at 1600° varies in the proportion of 4 to 1, and at ordinary temperatures in the proportion of 2.5 to 1.

The preparation of impalpable material should be done in a tube-mill, starting with siliceous material already in a fine state, such as the Fontainebleau sand, to which, if necessary, 5 per cent. of burnt clay brick can be added in order to introduce the necessary amount of iron and alumina, such as naturally exists in quartzite. On the other hand, the table shows that the amount of impalpable material should not be too large. Comparing experiments No. 1 and 3, it will be seen that a brick containing

TABLE 13.—*Effect of Varying Fineness of Quartz on Properties of Silica Brick*

No.	Composition of Mixture	Linear Expansion, %	Density		Crushing Strength, Kg. per Sq. Cm.		
			Apparent	Actual	At Ordinary Temp. Dried	At Ordinary Temp. Fired	At 1600° C.
1	Fresh quartzite, 75 Powdered quartz, 25 Lime, 2	5.2	1.63	2.35	15	165	30
2	Fresh quartzite, 75 Screenings, 25 Lime, 2	5.2	1.63	2.33	10	60	8
3	Fresh quartzite, 25 Powdered quartz, 75 Lime, 2	3.9	1.36	2.35	9	135	10
4	Fresh quartzite, 25 Screenings, 75 Lime, 2	3.9	1.36	2.33	6	52	3
5	Calcined quartzite, 75 Powdered quartz, 25 Lime, 2	3.2	1.57	2.33	10	120	25
6	Calcined quartzite, 25 Powdered quartz, 75 Lime, 2	3.0	1.35	2.34	8	180	15
7	Calcined quartzite, 25 Powdered quartz, 75 Marly clay, 6	5.0	1.40	2.35	9	150	9.5
8	Fresh quartzite, 25 Powdered quartz, 75 Marly clay, 6	5.2	1.43	2.36	9.5	160	6
9	Fresh quartzite, 25 Screenings, 75 Marly clay, 6	5.2	1.43	2.34	7	55	2
10	Fresh quartzite, 75 Powdered quartz, 25 Marly clay, 6	5.0	1.50	2.34	19	110	16
11	Fresh quartzite, 75	3.7	1.60	2.35	...	120	24
12	Powdered quartz, 25	4.1	1.60	2.36	...	150	28
13	Lime, 2	4.5	1.78	2.37	...	250	25

25 per cent. of impalpable has a crushing resistance at high temperature three times that of a brick containing 75 per cent. of impalpable; we would therefore recommend a proportion of 25 per cent. of impalpable material, passing the 200-mesh screen.

To obtain the larger grains there is no reason for using roller mills, and it is preferable to use some form of cylindrical crusher, requiring much less mechanical energy, and also yielding grains having a lamellar shape, which is most advantageous for the compactness of the brick.

If roller mills must be used, however, it is necessary to give them a sufficient weight, 5 tons at least, in order to enable them easily to crush fragments of quartz of the size usually delivered by the jaw crusher. If the roller mills are too light, they roll over the grains without crushing them, increasing greatly the cost of power and repairs, while also introducing particles of iron into the mixture, which later give rise to brown stains on the brick, after firing.

Addition of Fluxes

Lime is the only flux regularly employed by manufacturers of silica brick; the proportion is generally between 1 and 2 per cent. M. Bied has proposed to add to the lime either oxide of iron or alkali. The advantage of a flux containing oxide of iron is that silica is only slightly soluble in it at high temperatures, and therefore the tridymite network is less rapidly destroyed than in other fluxes. In Martin furnaces, the bricks of the roof are often impregnated with oxide of iron to a depth of 10 cm. without seriously diminishing their resistance to heat.

The presence of alkalies greatly facilitates the transformation of quartz into silica of low density, especially into tridymite. Alkalies can be introduced in the form of alkaline clay, such as the majority of marly clays, glauconite, and the clays of Fresnes and Salerne. On the other hand, alkalies have the disadvantage of exerting an energetic soluble action on the tridymite network. Our test No. 10, Table 13, was very satisfactory, nevertheless.

Lime alone does not seem a sufficient flux, for the pure silicates of lime do not fuse until they reach temperatures above those obtained in the firing of silica brick. The quartzites ordinarily employed, however, contain 2 per cent. of alumina and iron, which, with the lime, yield silico-aluminates and silico-ferrites, fusible at about 1200°. When very pure quartz is to be employed, it seems indispensable to add a certain proportion of oxide of iron. Silica brick are often made without any addition of flux, the mica, after crushing, possessing enough adhesive power to give the dried brick a suitable stiffness, and sufficient fusing power to permit recrystallization of silica during the firing.

The chemical composition of the fluxes is not the only important point; it is necessary to reduce them to a sufficiently fine state of division to

allow them to mix intimately with the silica; this is the more important in proportion to the amount of impalpable silica in the mixture. Well slacked, fat lime and natural clays are generally sufficiently fine; when well-burned hydraulic limes are used, which are always granular, it is necessary to pass them through a tube-mill with the impalpable silica. The best method to insure that a fat lime shall be sufficiently finely disseminated is to slack it in three or four times its weight of boiling water and then use the milk of lime without allowing it to become dry, in order to avoid agglomeration. It is not necessary to have all the water boiling at the start; the operation can be begun with a little boiling water, after which increasing quantities of lime and cold water can be introduced, as the heat of reaction develops.

Wetting the Mixture

The proportion of water added for the purpose of making the mixture workable should be enough to permit the brick to be carried to the dry house without danger of deformation. The quantity may vary from 8 to 16 per cent. according to the proportion of impalpable material; obviously, the larger the proportion of extremely fine grains the more water is required. Furthermore, the impalpable material so increases the compactness of the brick as to allow a larger proportion of water to be used without making the brick too soft. It sometimes happens, when introducing a large amount of impalpable material, that the operator forgets to increase the proportion of water; thereupon the brick, when subjected to firing, break in planes perpendicular to the direction of compression, owing simply to a lack of water.

Mixing

Mixing, for the purpose of distributing the flux uniformly throughout the siliceous mass, is the more necessary according to the proportions of fine material. We have not yet found a perfectly satisfactory process for controlling the distribution of lime throughout the mixture, although this is a very important factor determining the quality of the brick. Inasmuch as the mixing operation is not very expensive, it would be much better to increase the length of the mixing process, even beyond what would appear to be strictly necessary. The operation is generally conducted in light mills revolving rapidly.

On this subject, we would suggest the possibility of using, for mixing, the impact mills, which are used for the preparation of molding sand at foundries. We would also indicate, with some reserve, the possible advantage of introducing the water gradually. When it contains only 5 per cent. of water, the mass mixes readily and remains sandy; the additional water can then be introduced at the end of the operation, when it will distribute itself immediately and uniformly.

Molding

Molding of the bricks is most often performed by hand, although there is some doubt as to whether this process is better than the use of a molding press. It permits, possibly, a more regular distribution of the mixture in the molds, and yields brick which, at 1600°, possess the same mechanical strength as machine-pressed brick. In the case of badly fired brick, the final expansion, which occurs after the bricks are in the furnace roof, has better opportunity to relieve itself in the spaces of a very porous brick and thus produces much less external pressure. On the other hand, pressed brick, which are always dense and have greater strength at ordinary temperature, are much less permeable to the slag; this is important, as this permeability is an important factor in the destruction of brick. It would seem, finally, that for careful manufacture, high molding pressures are preferable, although for second-quality brick hand molding may be perfectly suitable.

Drying

The molded brick must be dried before they are introduced into the kiln because they would otherwise be too soft to permit them to be piled one on another; the abrupt application of heat, furthermore, would cause them to burst or at least crack by too rapid expelling of excessive water vapor.

The drying operation presents no difficulties and requires no special precaution. It is possible, immediately after molding, to put the bricks into a heated stove and dry them in a few hours. In this respect, silica bricks differ from clay bricks in that drying does not produce any contraction. With bricks containing a large amount of impalpable silica, the operation may require more care, but is never difficult.

Firing

Firing is the most important feature in the manufacture of silica brick, and also the most expensive; unfortunately the best conditions for firing are not yet fully understood. Tests are difficult to make on account of the length of firing and the dimensions of the furnace in which firing is done; firing often lasts for 20 days and may take place in a furnace holding 200 to 300 tons of brick at once.

The maximum temperature of firing is often considerably exaggerated. We often hear of firing temperatures of 1500° and even 1600°, but we do not believe that any silica brick are ever actually fired at temperatures exceeding 1400°, and base this belief on the two following facts: In the most intensive firing, the heat is generally limited to Seger cones No. 16 to 18, corresponding nominally to temperatures of 1450° and 1490°; numerous experiments, however, have shown us that in ceramic furnaces, in which the heat is maintained for a long time, Seger cones melt at

temperatures between 70° and 100° lower than in calibration tests, which are always conducted very rapidly. Furthermore, on examining the expansion of commercial brick, produced by subjecting to a second firing, we have determined that they all began to expand rapidly upon reaching a temperature of 1400°, which proves that they had not undergone this temperature in the first firing.

We believe, therefore, that a temperature of 1400° is enough for firing, provided it is maintained for a sufficiently great length of time. In any case, we do not believe that there is any advantage in exceeding a temperature of 1450°, even with the most difficultly transformed quartz. Our experiments, mentioned above, show that the Fontainebleau sand,

FIG. 11. FIG. 12.

FIG. 11.—SILICA BRICK MADE FROM SOUVIGNY QUARTZITE. CIRCULAR CLEAVAGES CHARACTERISTIC OF CRISTOBALITE, IN LARGE GRAINS OF QUARTZITE ENTIRELY TRANSFORMED BY THE FIRING. NATURAL LIGHT; MAGNIFICATION, × 34.

FIG. 12.—SILICA BRICK MADE OF SOUVIGNY QUARTZITE, SHOWING FRAGMENTS OF QUARTZ NOT TRANSFORMED BY FIRING. AROUND THE LARGE GRAINS IS A BORDER 0.01 MM. DEEP PRODUCED BY THE ATTACK OF THE FLUX. NATURAL LIGHT; MAGNIFICATION, × 34.

which is particularly difficult to transform, in the presence of lime is reduced to a density of 2.46 after 3 hr. of heating at 1400°.

Finally, numerous tests of mixtures containing Fontainebleau sand fired in industrial furnaces, have yielded densities between 2.32 and 2.36. As for the large grains of quartz, the transformation is less rapid and it would obviously be advantageous to introduce these, if this could be done, in the condition of quartz already transformed.

In addition to the temperature, it is necessary to take into account the length of time during which the maximum temperature is maintained, and also the rapidity with which the heating is conducted. In case of too rapid a heating, the brick expands enormously, the direct transformation of the grains having preceded the formation of the network. From the

theoretical point of view, it would seem that the best condition of firing would be to raise the bricks as rapidly as possible to the temperature at which the large quartz grains begin to transform directly, but slowly; this would give the network of tridymite an opportunity to develop more rapidly than the isolated grains transform, which is indispensable in order to limit expansion. This temperature would then be maintained a sufficiently long time to allow the transformation of large grains to be completed.

We should mention an absolutely contrary theory maintained by certain manufacturers on account of its economical advantages. This involves firing at a very low temperature, in order to form the indispen-

FIG. 13. FIG. 14.

FIG. 13.—INSUFFICIENTLY FIRED ENGLISH BRICK, CONTAINING UNTRANSFORMED GRAINS OF QUARTZ, ALTHOUGH BORDERED TO A DEPTH OF 0.01 MM. BY ATTACK OF THE FLUX. NATURAL LIGHT; MAGNIFICATION, × 34.

FIG. 14.—INSUFFICIENTLY BURNED GERMAN BRICK, CONTAINING ROUNDED GRAINS OF QUARTZ, INDICATING THE USE OF A NATURAL SAND. NATURAL LIGHT; MAGNIFICATION, × 34..

sable network, but allowing the grains of quartz to remain untransformed; the final heating is afterward finished in the steel furnace. This process has the advantage of not introducing cristobalite into the brick and thereby diminishing the danger of fracture; on the other hand, at high temperatures, brick of this character would be subject to considerable expansion, leading to a warping of the furnace roof. If, however, the proportion of impalpable silica has been sufficient, and if the firing has been sufficiently prolonged, the tridymite network may perhaps be sufficiently solid to offset the danger of expansion.

We should also mention a third theory, upheld by certain American authors; well burned bricks are good; slightly burned bricks are mediocre; but medium burned bricks are detestable. Such brick are composed principally of cristobalite and disintegrate into large fragments by fracturing.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the Milwaukee meeting, October, 1918, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Nov. 1, 1918. Any discussion offered thereafter should preferably be in the form of a new paper.

Low-temperature Distillation of Illinois and Indiana Coals

BY G. W. TRAER, CHICAGO, ILL.

(Milwaukee Meeting, October, 1918)

THE distillation of bituminous coals at what is commonly termed low temperature, and the quantities, nature and adaptabilities of the products have been the subject of considerable experimentation, during recent years. Fortunately, the earlier work in this country was done by men whose scientific training qualified them properly to record and interpret the results of their experiments. The work of Prof. Parr, of the University of Illinois, is especially notable in this respect.

Prof. Parr's work, added to that of English experimenters, demonstrated certain things to a degree which is generally regarded as convincing. They have proved that a caking bituminous coal, when subjected to a temperature of not more than 1000° F. (preferably somewhat less) will yield light tar having low specific gravity (about 1.06) and high value; also, that this yield, with a given coal, will depend upon the percentage of hydrocarbons in the coal, the maximum temperature used, and the promptness with which the distillate gases are removed. It is assumed that air is excluded from the retort, and that the coal is subjected to heat for a sufficient time to drive off all of the tarry hydrocarbons.

The results attained in the first, or low-temperature stage of the Carbocoal process, recently described by C. T. Malcolmson,[1] corroborate these general principles. It is the purpose of the writer to describe other work of a practical nature, directed toward the commercial adaptation of these principles, which was begun nearly two years ago; this investigation was assisted by A. J. Sayers, of the Link-Belt Co., and Carl Scholz.

The first step was to draft tentative designs for the handling of the coal and coke so as to produce a coke having a suitable structure for sizing, storage, shipment, and handling, without the necessity of briquetting. Prof. Parr's results had indicated that the rather open-pored volatile coke produced by him had a low ignition point, which would contribute toward easy control of the fire in stoves, house furnaces, fire-boxes, and boilers. It is recognized by those experienced in the marketing of fuels that the hard non-volatile coke from the high-temperature process,

[1] *Bulletin* No. 137 (May, 1918), 971.

while an excellent fuel in the hands of those qualified to handle it, nevertheless falls far short of being an ideal domestic fuel, and is still less well adapted to other uses, to which it was believed a high-volatile coke would be more suited. The high ignition point of hard non-volatile coke makes it difficult to burn satisfactorily in a small or thin fire With a strong fire the drafts have to be watched closely because of the tendency to over-intensity of combustion. In spite of its high heat value and cleanliness in handling, it has therefore fallen short of being a popular domestic fuel. Another obstacle to the general use of hard coke for domestic purposes is the fact that, during active periods in the blast-furnace industry, the furnaces will pay such high prices for the coke as to divert it from domestic use. Domestic consumers feel, therefore, that it is not a reliable source of supply at all times, and when the hard-coke makers wish to return to the domestic industry, they have to build up their business all over again, against a handicap.

Another important factor is that, while it has proved quite impracticable to use non-volatile hard coke in locomotives previously using high-volatile bituminous coals, without radical changes in the fire-boxes, the indications were that high-volatile coke could be employed for this important purpose, without material changes in the fire-boxes.

Experimental Plant

C. M. Garland was retained to revise the designs and supervise the construction and operation of an experimental plant, which was installed at Chicago in 1917. The operation of the plant began early in October and, with some stoppages for corrections indicated by its use, was operated until Dec. 24. Altogether about 140 tons of coal were passed through the plant, about 100 tons of which was Franklin County mine-run crushed to pass through a 2-in. round-hole shaker screen. The other coals tested, in lots ranging from 4 to 12 tons, comprised Harrisburg and Eldorado in Saline County, Ill.; Indiana 4th Vein from the J. K. Dering mine, Clinton, Ind.; Indiana No. 5 from Grant mine No. 4; and Indiana No. 5 from Knox County.

The plant comprised one oven or retort, together with the usual condensing and scrubbing apparatus for the distillate gas, and other necessary machinery and appliances.

The oven was horizontal and rectangular, about 60 ft. long, 4 ft. high and 20 in. wide. At each end was a double-door lock, one serving for the admission and the other for the withdrawal of the containers carrying the coal, without admitting any substantial amount of air. These locks were of suitable length to hold one container; they were not heated, nor was a space of the same length as the lock immediately inside of it. The remainder of the retort was supplied with down-draft flues, each of which led to a large off-take flue in the base of the oven, and thence to

the stack. The flues were about 1 ft. square in their inner dimensions and were laid with ordinary rectangular silica brick, as tongued and grooved brick in interlocking shapes could not be obtained for many months. As the volume of clean gas yielded by the low-temperature process is insufficient for heating the oven, provision was made to supply city gas for the additional heat necessary; in the commercial plant, producer gas will be supplied for this purpose.

A track was laid through the oven with 16-lb. steel rail, 11-in. gage, to carry the containers. These were introduced at intervals into the charging end, each successive container pushing those which had preceded it; when the retort was filled, a finished container would be discharged whenever a fresh one was inserted. The train of containers was pushed by a hydraulic ram, and they were charged with coal and the coke was discharged from them manually. In the commercial plant, the pushing will be done by an electric ram, and the charging and discharging will be mechanical.

The design of these containers was the central feature of our process. Those used in our experimental plant were about 4 ft. long, 4 ft. high and 12 in. wide. Partitions, 12 in. apart, divided each box into four sections, each 12 in. square. Each box was placed on a cast-iron truck mounted on four cast-iron wheels. When the truck and box were removed from the oven, the box was lifted off, the coke discharged, the box replaced on the truck, and returned to the other end of the oven for recharging.

One of the principal purposes of this form of container was to afford means by which the heat could be quickly conveyed through the mass of coal. Experience with the high-temperature byproduct oven has shown that when heat is applied only to the side of the charge, the progress of the coking is very slow, probably only ½ in. per hour.

It is impracticable to make a semi-coke of substantially uniform volatile content, unless special means are employed for conveying the heat to the center of the charge more quickly than is possible by means of a heated side-wall only, because if the side-wall temperature is not raised above 1000° F. the progress of the coking toward the center will be prohibitively slow; indeed, it has proved impracticable to convey the heat, at that temperature, through 10 in. of coal. If the heat is raised above 1000°, by the time the tarry volatiles are all driven off at the center of the charge, the volatile contents of the coke on the outer side will be greatly reduced, thus giving a coke of widely varying character. Furthermore, the higher temperature will cause a proportionate decrease in the valuable light oils and a corresponding increase in pitch; the percentage of coke also will be decreased. There will be an increase in gas, but it will fall far short of compensating for the losses mentioned.

The first container boxes were made of sheet steel, and were divided into four compartments each 12 in. square. It quickly developed that

this column was too large for short-time coking, with a reasonably uniform volatile contents. Additional compartments were then put in some of the boxes; while, in others, pipes of varying diameters were placed in the centers of the large compartments. Both of these expedients produced usable coke.

A cast-iron box also was used; the shell and partitions were ¾ in. thick, and the compartments varied from 4 to 8 in. in width. This cast-iron box showed great superiority over all other forms, and proved eminently satisfactory for the purpose. The compartments were tapered slightly, so that by the time the boxes reached the open air, the temperature had been reduced enough to cause a slight shrinkage and the coke slipped out of the compartments without difficulty. It showed no tendency whatever to cling to the metal.

Characteristics of Semi-coke

The semi-coke thus produced proved a most satisfactory fuel for all general purposes. Although our retort had only side-wall heat, we were able to produce a coke practically homogeneous in structure and volatile contents. By keeping the charge in the heat long enough, we could produce a hard coke with practically no volatile contents, or by withdrawing the charge as soon as it was fused to the center, we could change the coal into the form of coke while but little of the original volatile contents had been removed. Our experience indicates that the ideal fuel for general use is obtained by leaving about 18 per cent, of volatile matter in the coke; this gives a satisfactory yield of coke, while, at the same time, practically all the volatile-producing oil or tar has been removed, and the coke thereby rendered smokeless. Using compartments of suitable width, the coke is uniform in structure and has sufficient strength to permit sizing and handling. The specific gravity is somewhat less than that of hard coke, but not enough so to be a practical objection. The breeze and fines burn satisfactorily, either by themselves or with the coarse sizes; in fact, the behavior in the fire-box, in that respect, is quite similar to that of bituminous coal. It ignites as readily as bituminous coal. The fire is easily controlled, and was successfully banked for 8 to 10 hr. in house furnaces during severe winter weather. It burns with a short, bright, clear blaze, and is clean to handle and fire.

An 8-hr. test of the semi-coke made from three different kinds of coal was made on a switch engine in one of the large railroad yards in Chicago. The coals were Franklin County, Ill., Indiana Vein No. 5 from north of Terre Haute, and Indiana Vein No. 5 from Knox County. In clearing up the pile from which this tender load was taken, all of the fine stuff was gathered up with the coarse, so that there was a large percentage of it in the tender load, which, in proportion of coarse and fine, resembled mine-run coal.

There was a light coal fire in the locomotive and on this the semi-coke was started. It steamed rapidly from the start and made no smoke throughout the test. The amount of cinders thrown from the stack with a heavy exhaust was but a small proportion of the amount coming from bituminous coal. The semi-coke steamed rapidly enough to make it unnecessary to use the steam blower when the exhaust was off, as is done to lessen the smoke when bituminous coal is used; this effects a substantial saving of coal. The engine did its regular yard work for about 4 hr., the crew being changed at the third hour. By this time a thin clinker had formed which, however, was readily removed during the noon hour. Another thin clinker was formed and removed during the afternoon, but some coal, of which there was some at the bottom of the tender, had been fired on top of the semi-coke before this happened. The Engineer of Tests of the railroad stated that this clinkering probably resulted from the mixing of semi-coke made from three different kinds of coal, and from the excessive amount of fine stuff. Mr. Scholz, who was on the engine during a considerable part of the test, was of the same opinion; and they agreed that the semi-coke had satisfactorily shown its adaptability for locomotive use without material change in the fire-box. The semi-coke was entirely new to both firemen on this run.

In regular practice, a semi-coke made from one kind of coal will clinker less than the coal from which it is made. This is because the semi-coke burns up without permitting the lumps to break down or melt; there is, therefore, a better circulation of air through the fire-bed than with coal. In regular practice there also would be a great deal less fine stuff than was in this tender load. In a plant equipped entirely with casting-boxes, the plant run of semi-coke would contain a very small percentage of fine stuff; from his observation in our experimental plant, Mr. Garland estimates this at less than 10 per cent.

Volatile Products of Distillation

In the operation of our experimental oven, it was demonstrated that it would not be possible to use a brick wall between the side flues and the containers, and at the same time make a practically complete recovery of the oil and gas in the coal. This was partly due to the small amount of gas, ½ to 1 cu. ft. per pound of coal, obtained in the low-temperature process, as compared with 5 to 6 cu. ft. in the high-temperature process. A small air leakage, such as exists in the high-temperature ovens, would therefore produce disastrous results; even in high-temperature ovens, there is more or less trouble in keeping down the percentage of carbon dioxide in the gas. In our experimental oven, the use of plain silica brick instead of special interlocking brick increased the leakage materially, although special precaution was taken in laying up the brick and in coating the interior of the oven with special high-temperature cement.

The quantitative determination of gas and tar was therefore impossible with this oven. These factors, however, have been demonstrated repeatedly, not only by Prof. Parr, for practically every coal mined in the State of Illinois, but also by numerous others. The curves of Fig. 1 show the relation between the coking temperature and the tar produced, in gallons per ton, for a coal containing approximately 30 per cent. of volatile matter. These curves are based on experiments made by Lewes, and correspond with the results obtained by Prof. Parr. The Illinois and Indiana coals have 35 per cent. or more of volatile hydrocarbons and will therefore produce correspondingly more tar than the 30 per cent. coal illustrated in Fig. 1.

For our commercial oven, a cast-iron retort will be used, which will be lined on the flue side with silica brick. This retort is ribbed to prevent warping, and is fixed only at the center, leaving the ends free to expand.

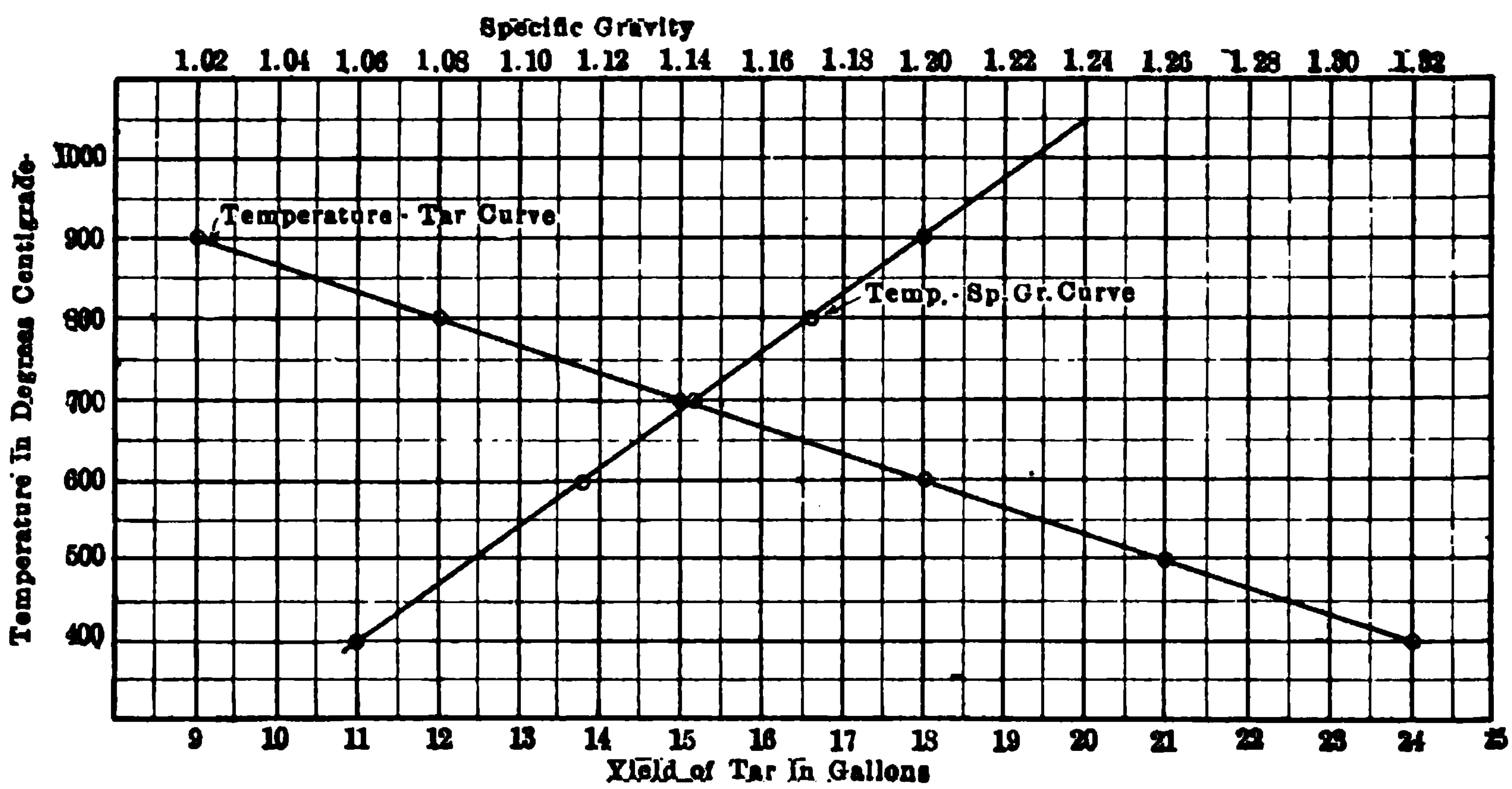


FIG. 1.—RELATIONS BETWEEN RETORT TEMPERATURE, AND SPECIFIC GRAVITY AND YIELD OF TAR, PER TON OF COAL CONTAINING 30 PER CENT. VOLATILES.

Since the temperature within the oven does not exceed 1000° F., this will not only insure a gas-tight construction, but the retort will be considerably more permanent than a brick structure, and will cost less for maintenance than brick retorts of this form.

The light tar produced by the low-temperature process is a liquid having the consistency of heavy cylinder oil. Its significant characteristics, as disclosed by Prof. Parr's work, are: first, the large percentage of the light fraction cut at 210° C. (about 18 per cent.); second, the large percentage of the middle fraction (about 52 per cent.) and the high percentage of the tar acids therein; third, the very low proportion of pitch (about 30 per cent. as compared with 65 per cent. or more in the heavy high-temperature tar), the low melting point of this pitch, and its low percentage of free carbon.

Taking Franklin County, Ill., coal as a basis, the results of operation

at our experimental plant indicated that the products of low-temperature distillation will be about 77½ per cent. of semi-coke having 18 per cent. volatile combustible matter, and about 25 gal. of light tar and oil per ton of coal. There will also be a small amount of ammonia, but since the nitrogen in the coal, which is the source of the ammonia, does not leave the coal freely until the temperature is considerably above 1000° F., the greater part of the nitrogen remains in the semi-coke; if this product is then made into producer gas in a byproduct plant, a very large recovery of the ammonia may be made. Treated in this way, the recovery from Franklin County coal would be about 100 lb. of sulphate of ammonia per ton of coal. This assertion is based upon data furnished by C. W. Tozer of London, England, regarding his experiments with a coal closely resembling that of Franklin County. In the high-temperature non-volatile coke plants, the nitrogen is all driven off the coal, but only the lesser part of it is recoverable as ammonia, because the temperature of the oven is so high that the greater part of the nitrogen does not combine with hydrogen, or, if such a combination is made at first, it is later broken up before it can be recovered.

Based upon our experience at our experimental plant, the heating period required with the casting containers will not exceed 8 hr., and it is probable that this may be reduced. The length of time required depends upon the greatest distance which it is necessary for the heat to travel through the coal. A shorter period could be attained by reducing this distance, but if it is too greatly shortened, the result might not be compensatory, by reason of structural and other considerations.

High- vs. Low-temperature Distillation

Ample data were secured from the operation of our plant upon which to base enlarged and perfected designs for a commercial plant, and to furnish a sound basis for estimating the cost of installing and operating it. This has been carefully worked out by Mr. Garland and the writer, and the results are very attractive as to earning power. Our plant will cost considerably less than a high-temperature plant of the same capacity, and our products will yield a larger return per ton of coal. Franklin County coal, which has a natural moisture content of about 8½ per cent. will yield 12 to 15 per cent. more semi-coke, by the low-temperature process, than can be derived from it as hard coke by the high-temperature process. There will be at least double the amount of tar and oil, and commercial investigations indicate that its value per gallon will be several times as great. The high-temperature process will yield several times as much gas as the low-temperature process, but the surplus gas is always sold at a very low price. The high-temperature process also has some advantage in the greater amount of ammonia produced, but this also is more than offset by other considerations The

opportunities for commercial development of the low-temperature process seem to be very great; it is not visionary to predict the substitution of semi-coke, in the Central and Western states, for a large part of the anthracite and so-called smokeless coals which now come into this territory, by rail or lake.

Members of the Institute are doubtless well informed as to the large number of valuable sub-products which may be derived from light tar and oil, and the rapidity with which this chemical industry is now developing in the United States. Dr. David T. Day is authority for the statement that the cracking process for deriving motor fuel from mineral oils has reached a stage of development indicating that it is possible, in this way, to secure nearly 20 gal. of gasoline, or motor fuel of the same value, per ton of Franklin County or similar coal.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the Milwaukee meeting, October, 1918, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Nov. 1, 1918. Any discussion offered thereafter should preferably be in the form of a new paper.

Notes on Certain Iron-ore Resources of the World

BY E. C. HARDER,* W. LINDGREN,* C. M. WELD,† A. C. SPENCER,* H. F. BAIN,† SIDNEY PAIGE*

(Milwaukee Meeting, October, 1918)

At a meeting of the New York Section, on May 23, 1918, the sole subject of discussion was the nature and occurrence of iron ores in certain parts of the world.‡ Owing to the importance of this subject, it has been deemed advisable to publish the remarks made at that meeting in the form of a paper, for presentation at the Milwaukee Meeting, instead of in the usual place, under News of Local Sections. The remarks related to the following districts: Brazil, by E. C. Harder, of the U. S. Geological Survey; Scandinavia, by Waldemar Lindgren, of the U. S. Geological Survey; Cuba, by C. M. Weld, of the U. S. Bureau of Mines; Southern Europe, by A. C. Spencer, of the U. S. Geological Survey; China, by H. Foster Bain, of the U. S. Bureau of Mines; Alsace-Lorraine, by Sidney Paige, of the U. S. Geological Survey.

BRAZIL

By E. C. Harder

During the years immediately preceding the war, the iron ores of Brazil were attracting the attention of iron operators both in Europe and in the United States. This was due to the large quantities of practically undeveloped ore available, and to its great purity. It is reasonably safe to state that had capital not been diverted from the exploitation of these deposits to war purposes, Brazilian iron ores would probably now be offered in European and American markets. It is certain that after the war these ores will play a prominent part in the economic reconstruction of Europe and perhaps in the development of America.

The Brazilian iron-ore field ranks among the six great iron-ore dis-

* U. S. Geological Survey.

† U. S. Bureau of Mines.

‡ For additional information on this subject, readers are reminded of the exhaustive work, "Iron Ore Resources of the World," published by the XI International Geological Congress, Stockholm, 1910. Two volumes and Atlas.

tricts of the world, the others being: (1) The Lake Superior district of the United States; (2) the Lorraine ore field of northern France and Southern Germany; (3) the magnetic deposits of northern Sweden; (4) the ore fields of Oriente, Cuba; and (5) the Wabana ores of Newfoundland. It is doubtless the greatest known undeveloped iron-ore district in the world.

The Brazilian iron ores are situated in the State of Minas Geraes, the center of the district being located about 250 miles in a direct line west of Victoria and about 225 miles directly north of Rio de Janeiro. The district is roughly 100 miles square and within this area are in the neighborhood of 30 known deposits of high-grade iron ore, having an aggregate tonnage variously estimated up to 3½ billion. The largest of the deposits contains, at a conservative estimate, at least 350,000,000 tons. There are numerous orebodies containing from 10 to 50 million tons. These estimates of ore tonnages have been checked by many engineers. They are based to some extent on exploration work but more largely on natural exposures, for the covering over the orebodies is scant.

The iron-ore district is reached by way of the Central of Brazil Railway, which runs northward from Rio de Janeiro through the iron-ore region to Pirapora, on Rio São Francisco. It cuts the district into two approximately equal parts. The Central of Brazil has sharp curves and steep grades. It crosses several divides and was not planned as an ore-carrying road. A new road, the Victoria a'Minas Railway, is now under construction westward from Victoria up Rio Doce into the iron-ore district. When completed it will be used primarily for iron-ore transportation.

The principal orebodies occur as huge lenses interbedded with extensive layers of siliceous sedimentary iron-bearing formation, known as *itabirite*, which covers many square miles. There is, however, another type of ore occurring in surface blanket deposits formed by the weathering of the iron-bearing formation. This ore is known as *canga*.

The interbedded ore lenses consist of both hard ore and soft ore. The former is of uniformly high grade, averaging about 69 per cent. metallic iron, being low in silica, and generally containing less than 0.02 per cent. phosphorus. The soft ore contains from 60 to 68 per cent. metallic iron, depending on the amount of silica present, and from 0.01 to 0.07 per cent. phosphorus. The canga ores are of lower grade, ranging up to 65 per cent. in metallic iron and carrying from 0.1 to 0.3 per cent. phosphorus. More than 500 analyses of various classes of ores and covering many deposits have been made by one company alone.

That iron ores existed in Brazil has been known for many years. The early gold discoveries in Minas Geraes, made more than 200 years ago, were in the iron-ore district. In fact, many of the gold-mining operations were in the iron-bearing formation itself, in which gold occurs disseminated through soft itabirite. Later the manganese ores of Brazil also

were discovered in the same region, and locally were directly associated with the iron-bearing formation.

That the iron ores themselves might be of value, however, was not suspected until recent years, due to a number of factors, such as: (1) The small demand for iron and steel products in Brazil, due to its still largely undeveloped industrial condition; (2) lack of coal suitable for iron manufacture in Brazil and neighboring countries; (3) the distance of the deposits from the coast, making the exportation of the ore a difficult problem.

About 8 years ago, Dr. Derby, then director of the geological bureau of the Brazilian Government, called attention to these great reserves of iron ore at the Stockholm Geological Congress. Shortly before this, English capitalists had made some initial purchases of iron-ore lands, and immediately thereafter, doubtless in part due to the publicity referred to, engineers of various nationalities began actively exploiting the deposits. In less than 5 years all but a few of the deposits were in the hands of English, American, French, and German interests, whereas previous to 1910 nearly all had been owned by native Brazilians. When the war began the development of the deposits was going on actively, but it soon began to decrease in vigor, and gradually stopped.

This being the general situation with regard to the Brazilian iron ores, the question arises as to what use will eventually be made of these ores and how they will affect the iron and steel industry of the world. In general, the Brazilian ore region may be compared to the Lake Superior district as it was 50 or 60 years ago. There is one great difference, however, that the Lake Superior ores were then in the midst of a rapidly developing country within easy reach of some of the richest coal fields in the world, while the Brazilian ores are in a region where there is no coal suitable for iron manufacture, and in a country which has not yet reached the stage of development when iron and steel in large quantities are being consumed. These factors necessitate the exportation of the iron ores to countries where coal is abundant and where manufactured products of iron and steel are used in large amounts.

The absence of rich, extensive coal fields in South America has been a great handicap to the development of Latin American countries. In only a few districts are coal mines being operated to any extent. The principal coal regions are the sub-bituminous coal fields of southern Chile, the sub-bituminous and bituminous coal basins of northern Peru, Colombia and Venezuela, and the bituminous coal district of southern Brazil. The latter is the only coal region within reasonable distance of the iron-ore district and, unfortunately, the coal is rich in pyrite. Frequent rumors of extensive coal beds in the Amazon valley have so far not been shown to be well founded.

The past history of the iron industry has shown that wherever iron-ore

fields have been developed the movement of the ore has been in the direction of the fuel-producing centers. It is less wasteful to carry iron ore to fuel than to carry fuel to iron ore, and thus practically all of the great iron and steel manufacturing centers of the world have been established in or near coal fields. At times, after years of progress, there is a movement in the other direction, such as we notice today in the establishment of manufacturing plants in the upper Great Lakes region, but such a movement is usually more or less artificial and does not form part of the natural course of development in any large degree.

The Brazilian iron ores, by being exported, can therefore never benefit Brazil as they would if fuel could be brought to the iron-ore field. The Brazilian Government is much concerned about the future exportation of this great natural resource, but it is now generally recognized that this is inevitable. Some years ago concessions were granted giving large bonuses on manufactured products to persons who would establish iron and steel producing plants in Brazil. In this manner it was hoped that a domestic iron industry might be started. But no capitalists have availed themselves of these offers, as it is generally recognized that an industry based on such bonuses is purely artificial. Perhaps, however, it may be possible to operate, without loss, plants of sufficient capacity to supply the domestic needs if such operations are linked with the exportation of ores.

As the absence of suitable coal makes the utilization of the ores in Brazil impracticable, so the inaccessibility and the transportation difficulties have delayed their development for export purposes. Even now prominent engineers do not believe that Brazilian iron ores can be landed in Europe or on the Atlantic seaboard of the United States at a profit. Most of the engineers who have carefully studied the situation, however, are confident that by efficient management it can be done.

As has been stated, English, American, French, German, and Brazilian capital is largely concerned in the ownership and exploitation of the deposits. The English and Americans are most heavily interested and, with one or two exceptions, control all the deposits in the upper Rio Doce basin which will be tributary to the new Victoria a'Minas Railroad. The Germans own two or three deposits in the Rio São Francisco Valley tributary to the Central of Brazil Railway. French and Brazilians own scattered deposits.

The Central of Brazil Railway is hardly capable of handling the manganese-ore traffic at the present time, amounting to approximately 500,000 tons annually. That it will be able to haul iron ore in any considerable quantity, besides the manganese ore, does not seem possible. The only ore which will therefore come out of Brazil for many years to come is the English, American, and perhaps some of the French ore, and this ore will probably go largely to English markets to replace the gradually decreas-

ing imports of Spanish and other high-grade iron ores. The English process of steel manufacture demands an ore low in phosphorus.

In the United States, in recent years, the basic open-hearth process of steel manufacture has rapidly increased in importance over the acid Bessemer process, making it possible for American furnaces to utilize increasingly larger quantities of ores moderately high in phosphorus. German steel works, by using the basic Bessemer process, have been able also to utilize high-phosphorus ores; in fact, a premium is paid in Germany for ores containing 1 per cent. and over of phosphorus. In both United States and Germany, however, there is a strong demand for the cheaply smelted low-phosphorus ores. In England, acid Bessemer furnaces have long been used more largely than basic furnaces and as the supply of Bessemer ores in Europe is gradually decreasing English furnace practice will have to change unless another source of ore low in phosphorus is found.

England has imported annually, during the last few years, about 4,500,000 tons of iron ore from Spain, about 1,000,000 tons from northern Africa, and about 800,000 tons from Scandinavia. It is hoped that the Brazilian output may eventually reach 10,000,000 tons annually, which will be sufficient to supply England's demands for foreign ores and leave a surplus for the United States and for other countries.

In the United States, the Brazilian ores will probably be found to be very desirable for mixing with low-grade ores and more refractory ores in the furnace. They will doubtless also be used in the Bessemer process to replace the gradually decreasing supply of domestic Bessemer ores. At the eastern seaboard furnaces they will compete with imported Cuban, Chilean and European iron ores.

The great fleet of vessels that will be necessary to carry the Brazilian iron ore to the United States and to Europe will be used to carry return cargoes to Brazil. This will offer cheap transportation for such products as coal, iron and steel, manufactured articles, and cement. It will aid greatly in the industrial development of that country and perhaps eventually it may be possible to operate small iron and steel plants in Brazil to supply the domestic needs of iron and steel products.

SCANDINAVIA

By Waldemar Lindgren

Scandinavian countries have long been known for their supply of iron ores, and Sweden more particularly has been renowned for a long time for the purity and excellence of its iron. I will discuss the Swedish iron ores first, referring first to the southern part of the country, and then to the northern part.

The southern central part of Sweden is the land of the old iron mines,

which for hundreds of years have furnished a most excellent ore, being extremely low in sulphur and phosphorus. There are a great number of mines there, the old celebrated mines of Dannemora, Persberg, and a number of others. They all lie in one district extending from east to west across the country at about the latitude of Stockholm. The high-grade ores, generally magnetites, occur in a great number of deposits, but the resources are relatively small; the ore is utilized for local smelting into very high-grade iron.

Geologically considered, these deposits are of a very interesting nature. They occur mainly as beds in lenses of limestone or dolomite, which, again, are imbedded in dense schistose siliceous rock. They are pre-Cambrian in age; most of the deposits were formed by replacement in limestone and dolomite, at very high temperatures. The nearest analogy in this country are the contact metamorphic deposits which we find in southern parts of the West. Along with these ores, and imbedded in the same gneiss, are also hematites, in alternating layers. These have never furnished any great production, and probably never will; they are of importance, but not for export. A great deal of discussion has been carried on regarding the origin of these ores; at the present, they are generally considered as of sedimentary origin, though highly metamorphosed.[1]

In central Sweden there is a third group, represented by only two or three deposits, comprising hematite ores. The leading producer is the great Grängesberg mine from which a considerable export is now carried on. These deposits contain considerable reserves, perhaps 100 million tons. These ores could not be utilized formerly, but lately a railroad has been built from the deposits down to the Baltic coast, and, until a few years ago, they were very largely exported to Germany. They occur in the same kind of rocks but in a different manner, so that, although subsequent metamorphism has pretty thoroughly veiled the original sources, it is believed that these ores are of igneous origin. They contain a considerable amount of apatite.

Summing up for the middle part of Sweden, we may say that the annual production amounts to perhaps 1,800,000 tons, but much of this comes from Grängesberg. This is not a big production and it is very widely scattered. The total reserves are not very large, either; they have been calculated at 122,000,000 tons, of which a large proportion belongs to the Grängesberg deposit.

Still another place should be mentioned: the old locality of Taberg, which has great geological and possibly economical interest. It is an enormous mass of diabase in which magnetite is contained. It forms a knob sticking up to a height of about 300 ft. and is visible for a long distance from

---

[1] H. Sjögren: The Geological Relations of the Scandinavian Iron Ores. *Trans.* (1907), **38**, 766.

the surrounding lower country. Unfortunately, the ore contains a few per cent. of titanium, which has interfered with its utilization, and at present it is not used. Little furnaces were there, however, as much as a hundred years ago. The celebrated chemist Sefström discovered vanadium in those iron ores. The percentage of titanium is not excessive and it is believed that the material can be concentrated and worked. That reserve, which amounts to a great many million tons, is included in the total given above. For the world as a whole, this deposit presents no particular interest.

It is altogether different with respect to the iron ores in the northern part of Lapland, north of the Arctic Circle. Here, too, the iron ores are contained in old pre-Cambrian rocks, but their relations are not so obscured by metamorphism as in the iron ores of southern Sweden, and their mode of origin can be more easily interpreted. These iron ores are of the greatest importance and contain reserves or developed ore to enormous extent. Altogether these deposits comprise some 10 or 15 different localities.

The first is the celebrated Kiirunavaara deposits, forming a mountain of iron ore which rises to a height of about 300 ft. above the lake, of the same name. The second is the deposit at Gellivare, which lies about 50 miles further south, about on the Arctic Circle; this is also of great size. Then there are about ten other places, many of them containing developed iron ores to the amount of 10 or 20 or 50 million tons. Altogether the iron-ore resources of Lapland are calculated at 1,150,000,000 metric tons; of this amount, something like 750,000,000 tons is credited to Kiirunavaara, about 250,000,000 tons to Gellivare, and the rest of it is divided among the other minor deposits. A characteristic of all of these iron ores is that they are rich in phosphorus. They all contain apatite, sometimes in very beautiful crystals. At Kiirunavaara the apatite is widely scattered through the ore, but is quite inconspicuous in form.

At Kiirunavaara[2] is a mass of practically pure magnetite, mixed with some apatite, which is exposed continuously from north to south for 4 km., rising about 300 ft. above the lake. The orebody has been bored to a depth of at least 300 m. below the lake, and contains, above the lake, something like 215,000,000 tons and below the lake about 500,000,000 tons. Apparently the deposit does not contract or pinch out in that depth. Extensive magnetic observations have been made, which seem to show that the center of the body lies at a depth of about 1000 m. below the surface so there seems to be considerably more magnetite than is contained in the prisms calculated to a depth of 300 m. This plate of magnetite lies between two sheets of igneous rocks, both referred to as syenite.

[2] See "Iron Ore Resources of the World," XI International Geological Congress Stockholm, 1910, 2, 558.

The mode of origin of the iron ore has been the subject of a great deal of discussion. At present, most geologists consider it to be a dike, developed from a magma which rested far below the surface, and there had time to differentiate into an iron-rich and an iron-poor part; the iron-rich part was then forced up between these sheets of syenite porphyry and formed this great ridge now standing up above the surrounding country. The ores differ in their phosphorus contents; a little of it is of Bessemer grade (0.05 per cent. phosphorus), but the bulk of the ore contains about 58 per cent. of iron and from 1.5 to 3 per cent. of phosphorus, as apatite. There are no other minerals present. The richest ores run about 68 per cent. in metallic iron.

The development of this great deposit has been made possible by a railway which runs down to Lulea on the Baltic in the east, and down to Narvik, one of the Norwegian fiords, on the west side. Immense docks have been built at both places, and export was proceeding at an intense rate, both to Germany and to England. The last accounts indicate that the annual production of iron ores in Sweden amounts to 6 or 7 million tons, of which the great majority, say 5,000,000 tons, comes from northern Sweden, of which, in normal times, perhaps one-third went to England and two-thirds went to Germany.

The second of these great deposits, Gellivare, is in many respects similar to Kiirunavaara. It is contained in rocks which, though of the same general kind, are yet different, inasmuch as they have been metamorphosed and made schistose. Gellivare consists of a series of lenses of magnetite in schist, which has been subjected to great pressure. The reserves are about 250,000,000 tons and the deposits are now being worked. The other deposits are of less interest; some of them contain as much as 50,000,000 tons, but they are small compared to these two giants.

Mining was formerly conducted at both Kiirunavaara and Gellivare by open cuts, but more recently they have substituted underground work for open cuts at Kiirunavaara, which were quite a hardship in the wintry climate, and at present most of the working is underground; this same plan of operation was in contemplation for Gellivare.

Passing over to Norway, until recently the production of iron has been small; the latest statistics show that only about 600,000 tons were produced in a year, but this does not prove that the resources are small. In southern Norway there are some deposits which correspond to those of middle Sweden, but they are of no international importance. In the northern part of Norway are three districts which are of special interest, and each of them differs a great deal from any of those which have yet been mentioned.

The first one is located at Sydvaranger, a part of Norway which adjoins Finland, on one of the fiords which extends to the Arctic Ocean. Here the rocks also are pre-Cambrian. The prevailing formation is

granite, but in this are imbedded, for a distance of about 20 km., a great number of lenses of magnetite. These are peculiar; they consist of an alternation of thin layers of quartzose gangue and magnetite, which have been folded and compressed to a most extraordinary degree. Here, also, the geologists have differed considerably; some consider these magnetites to be of magmatic origin, but I think they were probably originally in a sedimentary formation which has been surrounded by granite and gradually metamorphosed. The ores are low-grade, but there are about 100,000,000 tons available, and it is probable that they will be able to concentrate this material by magnetic processes; in fact, I have reason to believe that the last production from Norway, about 600,000 tons, was largely obtained by that method. The mining practice is to take the 35-per cent. ores by open cuts, and to mine underground those parts which contain 50-per cent. iron, which will amount to about 15,000,000 tons.

To the south or southwest of Sydvaranger, on the Lofoten Islands, are a number of hills that jut out from the coast of Norway, and a great many deposits are found very similar to those that I have just described, but none of them is of very great importance.

The last of the important deposits of Scandinavia are those of Dunderlandstal; this is one of the fiords that cut into the coast of Norway. Here we have about 150,000,000 tons of iron ore available by open-cut workings. They probably will not average more than 35 per cent. iron, and as the ore contains hematite, a great deal of capital has been sunk on experiments to discover a method of concentration. Of the quantity available there can be no doubt.

The Dunderlandstal hematite ores are of sedimentary origin, of Cambrian age, and are younger than any of the previously described deposits. They consist of well defined beds imbedded in limestone and somewhat metamorphosed sandstone.

In conclusion, I repeat that the total prospective iron-ore supply of Norway is about 218,000,000 tons, and that of Lapland 1,200,000,000 tons. The most important Scandinavian deposits, therefore, are Gellivare and Kiirunavaara, in Sweden.

CUBA

By C. M. Weld

Cuba, with its 3,000,000,000 tons of iron ore, holds a very important place in the world's iron-ore resources. Nearly 90 per cent of this enormous tonnage is comprised by the soft ores of the north coast of Oriente Province. There are less important areas of soft ores in Camaguey Province and in Pinar del Rio, while the reserves of hard ore found on the south coast of Oriente are estimated to be only about 5,000,000 tons.

Occurrence and Extent of Ore

The broad mountainous belt of country which follows the north coast of Oriente from Nipe Bay to Baracoa is underlain by serpentine, with an occasional coastal fringe of limestone. Lateritic weathering of the serpentine has produced very extensive surface blankets of residual iron ore. The direct derivation of this ore out of the serpentine has been repeatedly described[3] and need not be further discussed here.

Tremendous as these blankets appear to be in horizontal extent, they do not in fact cover more than a small proportion, much less than 10 per cent. of the entire serpentine area. They have been allowed to accumulate here and there on more or less flat or gently sloping tablelands; elsewhere erosion has removed them as fast as they have been formed.

There are three localities where the topographic conditions have permitted very extensive accumulations of ore. These have been recognized as so-called iron-ore districts and have been named, from west to east, the Mayari, the Levisa, and the Moa fields. In my paper of some years ago[4] I distinguished also the Taco and Navas fields, but I now include these two in the Moa field. Between these fields there are immense stretches of barren serpentine, with occasional *caitos* or islands of ore having little importance.

The ore blankets sometimes extend horizontally for several miles without a break. In thickness they vary from a foot or less up to 60 or 70 ft.; one drill hole was over 100 ft. deep in ore before reaching the underlying serpentine. The average depth is from 15 to 25 ft.; there is absolutely no cover. While the ores naturally vary greatly from place to place, owing not only to their degree of laterization but also to the nature of the immediately underlying parent rock from which they have been derived, they all show essentially the same characteristics. These are, more particularly, high contents of both hygroscopic and combined water, high alumina, and persistent contents of nickel and chromium. The nickel is always at least from 0.5 to 1 per cent. and may rise as high as 1.5 per cent. The chromium hovers with equal persistence around 1.5 per cent. Iron, silica, and alumina vary between wide limits. In what is generally ranked as ore, the iron (sample dried at 212° F.) will run from 40 to 50 per cent., averaging about 46 per cent.; alumina, from 6 to 14 per cent.; and silica from 2 to 6 per cent. Phosphorus is always well below the Bessemer limit, and sulphur is negligible.

The Mayari field lies 15 miles south of Nipe Bay. Nearly 40,000

---

[3] See *Bulletin* No. 135 (March, 1918) 670, for discussion of this subject, and a bibliography of other papers relating to Cuban iron ores.

[4] *Trans.* (1909) **40**, 299–312.

acres have been taken up, all by the Spanish-American Iron Co., a subsidiary of the Pennsylvania Steel Co., and therefore now owned by the Bethlehem Steel Co. These 40,000 acres are estimated to contain 600,000,000 tons of ore, of which about 530,000,000 carry over 40 per cent. metallic iron. This field is the only one that has been operated. I will return to it shortly.

The Levisa field lies some 15 miles east of the Mayari field and from 5 to 10 miles south of an excellent deep-water harbor known as Levisa Bay. The Guantanamo Exploration Co. holds all the ore-bearing areas of importance on this field, its estimated tonnage being about 75,000,000 averaging over 45 per cent. iron.

The Moa field is by far the largest of the three. It lies immediately south of the splendid harbor of Moa Bay, the ore at many places extending to the water's edge. The field stretches 12 to 15 miles inland, and possibly 30 miles from west to east. It lies roughly 50 miles east from Nipe Bay.

It is not to be understood that this entire area of some 400 square miles is covered by iron ore, although well over half of it is actually under denouncement. The mining claims, however, include a great deal of barren territory. They also include large areas of very lean ore, locally called salmon ore on account of its pink color, which runs only about 30 per cent. in iron.

There are five large interests on the Moa field and a number of small isolated holdings. The following summary of their estimated respective reserves is compiled from several sources:

1. The Bethlehem Steel Co., which includes the Spanish-American Iron Co. and the Bethlehem Mines Co., holds 78,500 acres, containing 1,170,000,000 tons of ore.

2. The Midvale Steel Co., by virtue of its ownership of the Buena Vista Iron Co., holds 19,840 acres, containing 300,000,000 tons of ore.

3. The Guantanamo Exploration Co. holds 7152 acres, containing 155,000,000 tons of ore.

4. The United States Steel Corporation holds 15,000 acres, estimated to contain 210,000,000 tons.

5. The Eastern Steel Co. owns 10,188 acres, estimated to contain 50,000,000 tons; and various individuals hold some 50,000 acres, containing probably about 100,000,000 tons of merchantable ore.

This makes a grand total of 1,985,000,000 tons of ore for the Moa Bay field. I have mentioned that these mines in some cases include a great deal of lean ore which would not be classed as over 40 per cent. Of this nearly 2,000,000,000 tons I estimate that there are about 1,572,000,000 tons which would run over 40 per cent. If we add the three places together, Moa, Levisa and Mayari, we find a total, in Oriente Province, of

approximately 2½ billion tons of all ores and about 2,000,000,000 tons of ore exceeding 40 per cent. iron.

I have referred to other areas of these ores in Camaguey and Pinar del Rio Provinces. The ores of these two provinces resemble, in all their essential characteristics, the Oriente soft ores. Of the Camaguey (San Felipe) ores there are estimated to be 400,000,000 tons with 40 per cent. metallic and 50,000,000 tons with 45 per cent. metallic iron. The Pinar del Rio field contains about 40.000,000 tons of ore which will probably average slightly over 40 per cent. metallic iron.

The grand total for the Island of Cuba thereby becomes 3,000,000,000 tons of all ores, of which approximately 2¼ billion tons exceed 40 per cent. of metallic iron (dry basis). The total tonnage in its undried condition carries about 33 per cent. metallic iron. We may therefore say that Cuba's iron-ore resources represent 1,000,000,000 tons of metallic iron.

These are enormous figures and very naturally doubt at once enters one's mind regarding their reliability. The answer must be that the estimates are based on abundant prospecting, including thousands of drill holes and many more thousands of samples. I have explained that the ores lie as a surface blanket with absolutely no cover. The horizontal measurements are therefore easily determined; and the depth and quality are determined by a very simple method of drilling. Wherever areas, previously estimated, have been re-checked by close drilling or by actual mining, the reliability of the prospecting has been amply confirmed. The drilling is done with hand augers, at a cost of from 2 to 2.5 c. per foot. A party of three men will progress at the rate of about 30 ft. per hour with average conditions.

Mining and Marketing

Since mining operations have been conducted only at Mayari, that field must furnish us with our information.

It will readily be appreciated that these soft clay-like ores offer an ideal subject for machine mining. The Spanish-American Iron Co. is now using Bucyrus drag-line excavators with 3-yd. buckets and 70-ft. booms. These machines, working continuously, can load fourteen 50-ton cars per hour. Needless to say, this capacity is never actually reached in practice, but the actual digging costs are very low. It seems not impossible that still better might be done, and at the same time some inherent difficulties of transportation eliminated, by hydraulicking these ores. I have myself made some preliminary small-scale tests in this direction, which have given promise.

I have spoken of the large content of water which is typical of these ores. The hygroscopic water amounts to from 20 to 30 per cent., generally about 25 per cent., and the combined water, at 212° F., is about 13 per cent. The total water is therefore about 35 per cent., or over one-

third the weight of the ore in the ground. It is, of course, highly desirable to eliminate this water before shipping. For this purpose, and also to improve the physical condition of the ore so as to minimize dust losses in the blast-furnace, the Spanish-American Iron Co. adopted nodulizing kilns of large dimensions, resembling cement kilns. Since that time, very successful nodulizing or sintering tests have been carried out, both with Greenawalt and Dwight-Lloyd machines, and it seems not improbable that considerable economies might result by using a sintering machine rather than a nodulizing kiln.

The present practice at Mayari is to produce nodules with 90 per cent. on 10 mesh. The composition of these nodules averages about as follows: iron, 55 per cent.; silica, about 4.5; alumina, about 13; chromium, about 2; nickel, about 1 per cent. Phosphorus is way below the Bessemer limit and sulphur is practically negligible.

Up to 1917, about 2½ million tons of nodules had been produced and shipped to Sparrows Point; this represented 7 years' operation. The maximum output was in 1913, when 491,713 tons were shipped. The present maximum capacity of the plant is about 500,000 tons yearly. Since 1913, however, bad times and more recently lack of ships have restricted the output. Before the war, sea-freight cost 85 c. per ton, including stevedore charges.

As to costs, I may quote Mr. Rand's testimony given in the Steel Corporation suit. His statement was that, with Mayari working to capacity, the nodules could be delivered on Atlantic seaboard for less than 5c. per unit; which may be assumed to be about $2.50 per ton. This, of course, was several years ago, and labor costs have risen in Cuba as well as elsewhere. The rise in the cost of fuel would also have to be considered in any estimate of today's probable costs. Sea-freights constitute a problem in themselves.

Metallurgical Practice

The metallurgist who is not familiar with what has actually been done with these ores might look askance at the high alumina and the chromium. On the other hand, he would no doubt readily admit the peculiar values which the nickel and chromium would give to the steel made from them.

The 2,500,000 tons of nodules which have been shipped to this country have all been smelted and converted into iron and steel, chiefly at Sparrows Point, but also to some extent at Steelton. That entire success had been attained with them was shown by Richard V. McKay[6] some 3½ years ago. At that time he recorded that a mixture containing a little over 60 per cent. of Mayari nodules was being smelted on a fuel

[6] Year Book of the American Iron and Steel Institute (1914), 85.

ratio of practically 1 to 1, and he had nothing but praise for the slag. Continuous runs have been made for months with 100 per cent. Mayari ore.

The resulting pig iron is very similar to spiegel in appearance, showing a white crystalline fracture with no grain. A peculiar feature is the high amount of combined and the low amount of graphitic carbon. It contains practically all the nickel and most of the chromium in the ore, low silicon, very low phosphorus, and small amounts of titanium and vanadium. These latter increase with the silicon.

In its natural condition, this pig is useful only for steel making. It has been shown, however, that as a mix with other irons it is extremely useful for castings, improving the chill and giving increased hardness and strength, while increasing only slightly the power required to machine it. With all sorts of chilled castings, particularly rolls, guides, crusher plates, car wheels, and other products subject to hard wear, mixtures including from 15 to 40 per cent. Mayari pig have given tremendously increased service.

Mayari Steel

In making steel with Mayari pig, the duplex process is used. This process as carried out at Sparrows Point has been fully described by F. F. Lines.[6] It will be enough to say here that the results have been entirely satisfactory. A large part of the chrome is slagged off and a steel of superior quality is produced, containing from 1 to 1.5 per cent. of nickel, and from 0.2 to 0.7 per cent. chromium, as desired. Sulphur and phosphorus are below 0.04 per cent. This steel may be forged, rolled, and machined as easily as carbon steel, and has from 8000 to 10,000 lb. per sq. in. higher tensile strength and elastic limit. Mayari rails have been tested in positions where the service was particularly hard and have given excellent results.

In Paper No. 108 of the International Engineering Congress of 1915, there is an interesting discussion of the use of Mayari steel in the Memphis bridge. A series of tests is given showing an elastic limit for large-size angles of 59,000 lb. and a tensile strength of 94,500 lb. per sq. in. Elongation and reduction of area also generously exceeded the specifications, which were 1,600,000 ÷ T.S. for the former, and 30 per cent. for the latter.

But Mayari steel shows its excellent qualities more particularly when heat-treated. By simple quenching in oil, track bolts are made with a tensile strength of 100,000 lb. For eye-bars, springs, crank-shafts, and all sorts of automobile parts, this steel is particularly useful. Being a natural alloy, there is not the same degree of segregation as when nickel

---

[6] *Trans.* (1915) **53**, 357.

or other constituents are artificially added. S. W. Parker has published[7] an interesting comparison between heat-treated Mayari and 3.5-per cent. nickel steels, which is most favorable to Mayari steel. He finds that the one may generally be substituted for the other.

In closing, I may emphasize the peculiarly excellent qualities of the materials which may be produced out of these Cuban soft ores, of which there are such enormous reserves. Mayari has but served as an example. The other fields will give exactly the same results. The ores themselves can be cheaply produced and offer no metallurgical difficulties which have not long been overcome in actual practice. When the world's shipping problem has once more been settled, these Cuban ores will be among the most available iron resources of the several countries bordering on the Atlantic Ocean, including the United States.

SOUTHERN EUROPE

By A. C. Spencer

In presenting a rude picture of the iron-ore reserves of the region surrounding the Mediterranean, I will not touch on the Lorraine problem, but will include the remainder of France. The International Geological Congress, in 1910, gives as an estimate of the iron ores in France 3,300,000,000 tons, of which 3,000,000,000 are assigned to French Lorraine, leaving 300,000,000 for the remainder of France. Since those estimates were made, geologists and engineers have been searching France with more or less care, and other estimates have been made—how reliable I am not able to judge. Recently, in one of our technical papers, I noticed that a German iron master, in addressing a meeting of colleagues, made a statement which, to use my own words, was to the effect that France was a dog in the manger, as she had 10,000,000,000 tons of iron ore at her command, including those of the home country and of the colonies, whereas Germany had but 3,000,000,000; hence France was standing in the way of Germany in refusing willingly to give up the 3,000,000,000 tons of ore in French Lorraine, which would give Germany only 6,000,000,000 and still leave France 7,000,000,000. The conclusion was that it would be only fair for France to divide up. Presumably, in those circumstances, a country with which we are at war would be inclined to exaggerate, so I suspect he has combined estimates of French engineers and German engineers with exaggeration enough to indicate that France is playing a mean part.

Let us scale down that estimate and allow that, outside of French Lorraine, France and her colonies may have 2,500,000,000 tons of iron ore, and it is perhaps within the realm of possibilities. The new ore

[7] *Iron Age* (June 7, 1917) **99**, 1380.

reserves, now partly developed, are in Normandy and Brittany. They consist of bedded iron ores of moderate grade, and rather siliceous. The most extensive development took place just prior to the war, largely under the influence of the German iron masters of Westphalia. Aside from that, iron ore on a small scale has been mined in nearly every department of France. They are scattered about the plateau of France and in the foothills of the Pyrenees and the Jura Mountains.

As we approach the Pyrenees we find a different type of ore, namely those occurring in veins and in many places as replacements of limestone. At the surface the ores are limonite, but as depth is gained they grade into carbonate or a mixture of limonite and hematite. It appears that ores of this class may have more industrial importance than they have been assigned in the inventory of the iron resources of the world. They range along the slope of the Pyrenees and extend into Northern Piedmont. If we go to the west face of the Jura Mountains, we find deposits of rather low-grade surface ores, and moderate deposits of metamorphosed sedimentary ores, the latter occurring also in Switzerland.

In Spain, in the Pyrenees, there are iron ores of two types; metamorphic ores in limestone near igneous intrusions, and the carbonate type carrying pyrite and other sulphides in minor amounts. In Spain, the ores that have been inventoried comprise the deposits adjacent to the Bay of Biscay, which have produced the largest amount of iron ore up to the present time, if I remember correctly, an aggregate of some 25,000,000 tons. The maximum annual production of Spain in 1913 was nearly 10,-000,000 tons. Elsewhere in the Pyrenees there has been an aggregate production, including the total of Spain, of somewhere around 33,000,000 tons of iron ore—not a very large amount. The reserves were estimated in 1910, together with 18,000,000 assigned to Portugal, at above 700-000,000 tons, so that to Spain we can hardly look for a long supply of the high-grade iron ores which has made Spain a principal contributor, on the one hand to Great Britain, whose Bessemer steel industry she has largely supported, and on the other hand to Germany, to whom she has furnished a very large part of such low-phosphorus iron ore as she has required.

Considered with reference to the world's supply, the iron resources of Italy are almost negligible. In the center of Italy are widely separated deposits. Then in Northwestern Italy, in the Aosta district, there are magnetite deposits of a considerable size, of about equal importance with those of Elba, which thus far have been the only deposits to be worked on a large scale. These are ores of direct igneous origin. Then in Lombardy there are some deposits of a sedimentary nature, but from the world's standpoint we can ignore them. Italy has neither fuel to meet the requirements of the blast furnace nor iron ores to support a long-lived industry.

The iron resources of Austria-Hungary are also moderate, being rated at some two or three hundred million tons in the aggregate. In Bosnia and Herzegovina there are small deposits, and presumably in Servia some moderate deposits, whereas Greece has a goodly supply for a small country, stated at 100,000,000 tons of nickeliferous chromiferous ores of a class very similar to the Cuban ores. In passing, it may be said that some of the essential points in the metallurgy of these chromiferous ores were worked out in connection with the Grecian ores. These ores do not occur as surface blankets, but I believe that it is not amiss to state that they are of precisely the same type as those of Cuba. They have been covered by the limestone and sandy shale, but they were formed as a result of the weathering of serpentine rock precisely as in Cuba and in various other parts of the world.

This short outline can now end with a consideration of the iron ores of Algeria, and Tunis. All I can say of them is that iron ores occur at various points along the Atlas Mountains, and are of various origins, largely siderite replacing limestone and, like the carbonate ores of France and Spain, carry varying proportions of sulphide minerals. They have been rated at between 100 and 150 million tons of ores, averaging about 50 per cent. iron, and in large part of Bessemer grade.

On the whole, it is fair to say that, aside from French Lorraine and parts of Brittany and Normandy, the iron reserves of the countries surrounding the Mediterranean do not measure up to those of the Lake Superior region or those of Newfoundland, Cuba, or Brazil.

CHINA

By H. Foster Bain

It has been customary for many years to look upon China as containing one of the great iron-ore reserves of the world. This notion probably came about through the writings of Von Richthoven, who, in his journeys through China, passed through many regions in which iron was made; particularly in Chih-li he saw large numbers of furnaces, and excellent coal, and came to the conclusion that that would be one of the great iron-ore districts of the world. At the time he went through this country, the world was still using small furnaces, such as those of which you will find ruins in the Mississippi Valley. Places we have forgotten about were running then, and also small local furnaces were running all over Europe, so the conditions were such as to give some justification for the opinions he gave.

Recently the iron ores of China have been studied with considerable care by the Japanese, by the Chinese themselves, and by various foreign engineers, and we can say with some assurance that the old idea of iron-ore reserves is wrong, that the iron-ore reserves of China are very moder-

ate in comparison with the previous notions or opinions. In a general way, I may say that, making full allowances for the iron ores suitable for treatment by the native methods, China still has to be classed with Spain rather than with Brazil, United States, or the Lorraine district. The best estimate that I am able to give you for the total of the iron-ore bodies which are of such type, character, and situation as to be suitable for modern blast-furnace work is in the neighborhood of 400,000,000 tons. V. K. Ting, the head of the Chinese Geological Service and a very capable man, estimates the additional amount of iron ore which may be worked by Chinese local furnaces as 300,000,000 tons, but for practical purposes we are clearly safe in assuming that the iron ores of China are in the neighborhood of 400,000,000 tons.

Of this, approximately one-third was still in the possession of the Chinese Government last year; that is, the title belonged to the Chinese Government, although titles are in quite a dubious condition. The Chinese Government has been attempting for some years to reëstablish its right to the mineral under the land, and it has succeeded fairly well so far, at least, as the big iron-ore deposits are concerned. Chinese-owned companies held something less than one-third, and the Japanese and Sino-Japanese companies had more than one-third. In the whole of China there was not one single deposit that belonged to the nationals of any other country.

As to the character of the deposits, five types can be distinguished.

1. Ancient banded deposits. These contain both hematite and magnetite; they are of uncertain origin and the grade is also open to dispute. They occur mainly in Manchuria, and they are the ones of which we have heard some very large estimates. Those estimates seem to include the lean ore which will have to be concentrated to make it workable, and in nearly every case the actual amount of ore which can be used directly in a furnace is relatively small. Whether the lean ore can be worked on a large scale and concentrated is a technical question and such work runs into cost rapidly. Some preliminary tests of magnetic concentration in one case did not work out favorably, but others may be more successful.

2. Sedimentary carbonates and hematites, such as are in Shan-si. This is the type which Von Richthoven saw. When the Pekin Syndicate studied the question and W. H. Shockley investigated the field, he pointed out that the individual masses of ore are so small that they are unfitted to feed any modern furnaces. The individual lenses are 3 to 6 in. thick and up to 16 ft. in diameter. This does not look very attractive to a man who owns a modern furnace. In Pao-king and Hu-nan they have the same type of ore and some pig is made; this is generally marketed in the form of castings.

3. Sedimentary Oolites.—One such deposit occurs in Chih-li. These ores are extensive and probably valuable. A second deposit is in Kiang-

si and it is probably too lean; that is, while there are perhaps 30,000,000 tons of ore in a particular place, the bulk of it is probably too lean to work. The story of genesis there seems to be exactly the same as in the Mesabi districts but the leaching and enriching has not gone so far, so that we can hardly look for any considerable deposits of ore there.

4. The most important is the contact metamorphic type in the Yang-tze Valley. In the opinion of Dr. J. G. Andersson, these ores are found only around the edge of lacolites. The deposits vary considerably in character and grade, and a number of them are workable. It is difficult to make exact estimates of contact deposits without very accurate prospecting, which has not taken place.

5. Residual Deposits.—There are brown ores in the Yang-tze Valley and probably there is a larger amount of brown iron ore in the southern part of China than has been appreciated, but it is very likely in small scattered deposits and in conditions not very favorable for development.

I can cite one or two examples of the way these estimates scale down on examination in the field. You have all seen estimates of an iron deposit of Fu-kien; it is usually given as 10,000,000 tons of iron ores. Examination of that deposit showed a maximum of 2,000,000 or 2,500,000 tons of ore, and that a large amount of black porphyry had been confounded with iron ore. There are three recent estimates of the Tayeh deposits (at one time supposed to contain 300,000,000 tons) which seem to check fairly well and indicate perhaps 30,000,000 to 40,000,000 tons of workable iron ore. The best information seems to be that there is just about enough iron ore there for the company to fulfil its existing contracts. There is, of course, the possibility of finding more, but in contact beds that is an uncertain resource.

We have had an example in this last year of how important iron ore is to a nation. At the time that the United States went into the war and had temporarily to shut off exports of steel, the Japanese shipyards were in very bad shape, because the steel consumption in Japan had gone far beyond its capacity to produce, and it was found that if the shipyards were to be kept going it would be necessary to cut off absolutely all other use of steel, for the maximum of their local consumption was barely enough for their shipyards alone.

Originally the Japanese and the Chinese had about the same amount of iron ore *per capita*, but the Japanese woke up before the Chinese did and they proceeded to acquire additional quantities of iron ore. Japan had been depending largely on agricultural resources. She has an expanding population and has not had the same opportunity to spread out in new territory that we had in our great West, or as the British had in Australia, Canada, and South Africa; hence the Japanese had found that it was necessary, in order to maintain themselves, to change the character of their civilization and become a manufacturing and shipping nation in-

stead of an agricultural nation. In order to do that, it was necessary to secure large deposits of iron ore. It is from this fundamental point of view of necessity that Japan has been so insistent on acquiring additional iron ore. The Chinese have not felt that necessity yet, because they have not yet, in any large number, come to the conclusion that they must change the character of their fundamental industries.

ALSACE-LORRAINE

By Sidney Paige

About 6 months ago I became interested in the Alsace-Lorraine matter from the standpoint of the policy of the United States in its relation to these areas, and the possible peace between the Allies and Germany. I feel that ultimately the problem of solving this difficulty must rest, at least I hope it will rest, on geologists, engineers, metallurgists, and technologists.

Never before, perhaps, in the history of the world has the policy of a great nation been fraught with more momentous consequences than is the policy of the United States at present. To any thoughtful man impressed with the "velocity" of modern civilization, it must be evident that "direction" of movement is of vast importance, if the best interests of humanity and of that which is best in modern civilization are to be preserved and fostered. It is a significant fact that today there remains no great unpopulated territory. The westward movement of peoples, a movement impelled by economic pressure—a search for resources and later for markets—has slowed down. The great resources of the world are known. No longer may nations cramped by expanded industrial systems seek relief, without meeting unparalleled opposition, or without upsetting the industrial balance of the entire world. Trade, the cause of many wars, now links together the nations of the entire globe, and there is every reason to believe that science, which in a brief past has so marvelously obliterated time and space, will in the future accomplish even more. It follows that the political task of modern life must relate to equitable economic adjustments of nations. The waves of peoples inundating the world have met around its circumference, and man is confronted with the responsibility of seeing to it that some measure of quiet is established.

Problems of great difficulty confront modern civilization, even though the Utopian assumption be made that the last great war is being waged. These difficulties arise from the patent inequalities in resources, nature of peoples, ethics, education, and all that this implies. The spirit of self-preservation, persisting as selfishness, the desire for surplus and power, are apparently innate in human nature. But there are other traits in human nature which, it is the hope of many men, may dominate the world.

No one who analyzes the "regulation," adopted by the great industrial nations involved in this war, can fail to realize that in its very essence it is unselfish. It has to do with the "greatest good for the greatest number" and has been promulgated by free peoples. In fact, by *the people.* He who imagines that these changes have been born but to die an early death, lacks vision. They will be nurtured, cultivated, and will thrive—to grow into a body of procedure of vast importance to the welfare of man.

> War is modifying our views of labor, of distribution, of public finance, and production. In fact, it is shaking the whole traditional structure of our economic life.[8]

The principle is being established or will be established "that the essential commodities are subject to control in the public interest precisely as are the utilities."[9]

Nations now at war are applying these ideas. In the coming period of peace, it is vital that something of this wisdom be applied *among* nations.

There are two great aims in this war, and their importance justifies any sacrifice. First, the arrogant, autocratic, military despotism of Germany must be crushed. Nothing is clearer than this—that control in Germany has lain in the hands of a ruthless group—so strong indeed that they have been able to carry on a biological experiment on a vast scale. A people have been imbued, from the cradle to the grave, with a philosophy which appears to us no less false than cruel. The people exist for the State, and the particular State in question is a relic of barbarism and the philosophy built upon a decadent idea that the State can do no wrong. Our second aim of the war has to do with such redistributions of resources and territory as will tend to preserve peace and lead to the normal industrial progress of nations. And it is in this connection that the iron ores of Lorraine are involved. The position of the United States is unique. Her resources are the greatest in the world; her peoples are imbued with the virility of all great peoples, and her position geographically with respect to trade is, to say the least, remarkable. She lies between Europe and Asia. Great trade routes will meet and pass through her territory. And she has entered the war at a stage either when her weight will compel decision (and thus determine the nature of the coming peace) or else she will go down in defeat, which is unthinkable.

Practical men realize that, in wars, agreements usually follow a decision by arms; but never before in war has a decision by arms so completely involved the entire genius of peoples, so thoroughly tried their powers of coöperation or been so fraught with possible unexpected developments. Therefore, never before has it been so important to have well defined

---

[8] William S. Culbertson: *North Amer. Rev.* (Jan., 1918) **207,** 61.

[9] Charles R. Van Hise: *Science,* N. S. (Jan. 11, 1918) **47,** 36.

policies. It is well recognized that without the iron ores of Lorraine, Germany could not have waged the present war; and therefore that if these ores be taken by force of arms peace will follow almost at once. The general staffs of all the great nations are no doubt aware of this fact; likewise the Germans.

It must be recognized at once that in Lorraine (leaving Alsace out of the discussion for the moment) and contiguous France, there is today the greatest iron-ore reserve of Europe. No single factor, perhaps, no group of facts involved in this war, deserves more thoughtful consideration. Upon the proper disposition of these reserves, upon the nature of the barriers that may be set up or torn down in their utilization, upon the spirit of coöperation or competition which enters into their disposal, depends in large measure the future peace of Europe.

It is of interest to analyze briefly the present situation with respect to Alsace-Lorraine.

Alsace-Lorraine has been the battle ground of Europe ever since the days of Caesar when, in 72 B. C., a German tribe invaded this territory and settled down. It is useless except for moral discipline when feelings of self-righteousness become acute to dwell upon the number of times this fair territory has changed hands. Enough, that in 1871, France lost half of it to Germany. And it is significant to note that before this date it belonged wholly to France, left to her by the preliminary agreement of Versailles at the end of the Franco-German war, but that the German geologist, Hauchcorne, pointed out to Bismarck the potential value of this area, and France was persuaded to cede a strip of it by the subsequent treaty of Frankfort in exchange for land of military value near the fortress of Belfort. Geologists, therefore, were already, in 1871, of use to their governments at war. Since that time any lack of foresight on the part of French geologists has been corrected. They realize today the value of Alsace-Lorraine.

Coal and iron are so important in modern war, and the Germans, so well supplied with certain other necessities, are so ingenious in devising substitutes, that a consideration of such other necessities must take second place. Germany has vast resources in coal but poor resources in iron; but if the resources of Lorraine be included the resources of Germany in iron become vast. And if there be included French territory now held, she possesses by far the greatest resources on the eastern hemisphere. Of a production of 28,600,000 tons of iron ore in 1913 by Germany, 21,000,000 came from Lorraine; of coal, Germany, without French territory, possesses more than half the resources of all Europe. England follows her in resources, Russia next, then Austria-Hungary, and fifth comes France. The Saar Valley alone contains more coal than is known in France today.

One does not need a vivid imagination to picture the strength of this

combination which at present she commands, the greatest coal and iron resources of Europe.

France, on the other hand, is deficient in coal. In iron, before the war, her resources were only slightly less than those of Germany, and of a total production of 21,700,000 tons by France, 19,500,000 came from the Longwy-Briey field, the identical field from which Germany draws her main supply.

Briefly then, what was the situation before the war? Simply this: Germany, by unparalleled activity in the development of great coal resources, was using not only all the iron she could command, but importing an increasing amount year by year from France. France, on the other hand, short of coal, was importing some 23,000,000 tons and exporting iron ore to the amount of one-tenth of the production of the Longwy-Briey field, to Germany.

Then came the war, and with it changes of the utmost significance, for not only does Germany now hold the entire Briey-Longwy iron field, but also, in the north of France, the coal field extending from Valenciennes to beyond Lens.

The battle line on the western front offers opportunity for speculation. After the great advance which threatened Paris (German troops were within 20 miles of the city) the invading armies withdrew to the line of July, 1916. Recall the position at that time of the St. Mihiel salient and recall the line around Verdun. Note also that the great manufacturing center of Lille and Lens are in German hands and that the tip of the Flanders coal field alone remains in French possession. From that date the line moved to that of September, 1917, and again recall that the St. Mihiel salient has not changed; recall that the ferocity of the attacks upon Verdun were unparalleled and note that Lille and the Flanders coal field have not been relieved.

Much has been written to account for the German onslaughts at Verdun; political reasons have been assigned. Only recently, it would seem, has the true significance of this maneuver been understood. The St. Mihiel salient and Verdun are in the path to the Lorraine iron fields. That the Germans should desire to straighten this line is natural and that it remains nearly stationary means that it is well defended. Indeed, a great German offensive may be expected here. To regain the Flanders coal field would relieve a great need in France. To regain French iron fields and drive the Germans from Lorraine would change the aspect of the war.

Let us turn now to the war aims of French geologists and metallurgists. DeLaunay foresees France at the end of the war "triumphant, happy. * * * We impose our wishes, we impose them completely. I do not consider any other hypothesis as possible, as worthy of discust sion." And the conditions that he expects to be imposed include no-

only the restitution of Alsace and Lorraine, but the annexation of sufficient German coal and coal fields to redress the mineral deficiencies of France.

In 1913, France produced 40,000,000 tons of fuel, while her consumption reached 60,000,000 tons. A deficit of 23,000,000 tons, therefore, growing year by year, required imports from England, Germany, and Belgium to supply her needs. Of coke, which is the principal element entering into the cost of pig iron, the situation before the war was even more unfavorable. The 3,000,000 tons which were imported approached the figure of domestic production.

As has just been said, France before the war faced a deficit each year of 23,000,000 tons of fuel. This figure represents 19,000,000 tons of coal and 3,000,000 tons of coke (4 tons of coal to produce 3 tons of coke). Lorraine alone produces 4,000,000 tons of coal but no coke, and consumes 6,000,000 tons of coal and 4,500,000 tons of coke (made from 6,000,000 tons of coal). A total of 12,000,000 tons of coal, therefore, is consumed in Lorraine, while this territory produces only 4,000,000 tons. There is a deficit, therefore, of 8,000,000 tons of coal in Lorraine. Therefore, if Lorraine is returned to France, the deficit of that country in coal will rise from 23,000,000 tons to 31,000,000 tons. The French, therefore, propose that they also be given the coal of the Saar Valley in Germany. Should this wish be realized, the consequences are as follows: The Saar Valley produces 10,000,000 tons of coal, which is consumed crude, and 3,000,000 tons of coal, which is made into coke, 13,000,000 tons in all. This region consumes 5,000,000 tons of coal (2,000,000 as crude coal and 3,000,000 transformed into coke). There is a surplus, therefore, of 8,000,000 tons of coal, that is to say, precisely the amount deficient in Lorraine.

But this apparent balance of resources takes on a different aspect when analyzed with respect to coke.

Lorraine and the Saar Valley together produce, as set forth above, 17,000,000 tons of coal, divided as follows:

Coal consumed crude	14,000,000 tons.
Coal made into coke	3,000,000 tons.

This territory likewise consumed 17,000,000 tons of coal, but this amount is divided thus:

Coal consumed crude	8,000,000 tons.
Coal made into coke	9,000,000 tons.

Now, while the deficit of 23,000,000 tons which France faced before the war will not be augmented if Lorraine and the Saar Valley are taken, her situation with respect to coke will be worse. Before the war the 23,000,000 tons deficit of France was divided as follows:

19,000,000 tons of crude coal.
4,000,000 tons of coal for coke.

With the new arrangement these figures will become:

13,000,000 tons of crude coal.
10,000,000 tons of coal for coke.

The importations of metallurgic coke into France in 1913 were divided as follows:

	Tons
From Germany	2,393,000
From Belgium	547,000
From other countries	130,000
Total	3,070,000

There is therefore a deficit of nearly 7,000,000 tons of coke which France must make up by import. The Saar Valley does not produce good coking coal and France wants coking coal, not coke, for she wishes to obtain the byproducts. Eng and, before the war, consistently refused to send coking coal and would sell only coke. France after the war will be forced to buy fuel. Where can she buy coking coal? And just here the basic principle is illuminated, that nations must cöoperate.

If the situation in France with respect to ore is examined, assuming that she possess, after the war, Lorraine and the Saar Valley, it will be found that she faces an equal predicament—that is, a market for her ores. This is clearly set forth in the analysis by Robert Pinot.[10] But the crux of the matter is reached when the situation with respect to the manufacture of steel is analyzed.

In 1913, France produced 5,311,000 tons of pig iron; 957,000 tons were consumed by French foundries or exported crude. The remainder, 4,354,000 tons, was made into iron and steel. Lorraine and the Saar Valley in 1913 produced 5,241,000 tons of pig iron, of which 4,502,000 tons were transformed into steel. France after then would have a capacity of 11,000,000 tons of pig iron, of which 9,000,000 tons would be made into steel. Furnaces erected during the war would supply another million tons of steel. France thus would be compelled to dispose of 10,000,000 tons of steel. Where would this steel go? It may be shown that, even if a roseate view is taken of the French industrial situation after the war, France will be in a position (always assuming that she possesses Lorraine and the Saar Valley and ample coal from Germany) to produce 4,000,000 more tons of steel than she can dispose of. Pinot estimates as follows:

	Tons
French consumption before the war	5,000,000
Lorraine-Saar consumption	400,000
Exportation and reduction of temporary importation.	600,000
Total	6,000,000

[10] Robert Pinot: La Métallurgie et l'après guerre. *Bulletin et Comptes Rendus Mensuels, Société de L'Industrie Minérale,* 1re livraison de 1917, 36.

ximately remain unaccounted for.

ported....................	6,500,000 tons of steel
orted.............	5,000,000 tons of steel
s exported...............	2,500,000 tons of steel
orted	1,700,000 tons of steel

to develop exportation at the expense of the y which has enormously increased her capacity an she hope to compete with Great Britain, who n a strong position metallurgically. And as for ome 1,184,000 tons for export. Again, therefore, nto competition with the Germans.

n and presents figures, to the end that Germany e is no need to review these figures here. Their act that this entire question deserves the most n the part of the United States, England, and able basis for peace may be reached.

orings out clearly the need of an economic policy osal of the Lorraine and contiguous French ores. borne in mind that this iron-ore reserve is of all the great industrial nations of Europe. If the the military autocracy of Germany victorious, ther thought to this matter. Such a Germany slaved Europe will pay tribute.

ting one sentence. Upon the proper control of ne nature of the barriers that may be set up or zation, upon the spirit of competition or cöopera- neir disposal, depends in large measure the future

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

Petrographic Notes on the Ore Deposits of Jerome, Ariz.

BY MARION RICE, NEW YORK, N. Y.

(New York Meeting, February, 1919)

THE copper-mining district of Jerome, Ariz., is of such economic importance that the following brief notes may be of interest.

The ore deposits are said by Ransome[1] to be pre-Cambrian, and are contained in the pre-Cambrian schists of the region.

In the vicinity of the mine (the United Verde) the schist stands nearly vertical and strikes a little west of north. At least three varieties are distinguishable—(1) a green rock, schistose on its margins but grading into massive material, which is evidently an altered dioritic intrusive; (2) a rough gray schist with abundant phenocrysts of quartz, apparently an altered rhyolite; and (3) a satiny, greenish gray, very fissile sericitic schist that may be a metamorphosed sediment. The ore occurs in varieties (2) and (3), the main belt of dioritic rock (1) lying just west of the orebodies. The ore is said to follow as a rule the layers of fine sericitic schist.

T. A. Rickard[2] says that the ore at the United Verde Extension mine is found at the contact of diorite and schist, that both diorite and ore are earlier than the regional metamorphism, and that the quartz porphyry ("rhyolite" of Ransome) is of post-Cambrian age.

The material considered here, a part of which was gathered by the writer, came from four of the mines of the district, and its study was undertaken at the suggestion of Dr. Berkey of Columbia University. The field relations and exact locations of the different specimens are not known, but a microscopic study of the thin sections gave some evidence as to the origin of the ore, which will be discussed below. The indications are that both ore and porphyry were introduced at the closing stages of the metamorphism, this being in accord with Ransome's view of the genetic relation of porphyry and ore rather than with the opinion that the ore is related to the diorite. Certain field occurrences mentioned in the literature also support this theory. Rickard, in the same article to which reference has been made, speaks of a vein of chalcocite several inches wide at the contact of one of the porphyry dikes, and Provot,[3] although he regards the porphyry as subsequent to the ore, says: "Acid dikes encount-

[1] F. L. Ransome: *U. S. G. S. Bull.* 529 (1913) 192.

[2] T. A. Rickard: *Mining and Scientific Press* (Jan. 12, 1918) **116**, 47.

[3] F. A. Provot: "Geological Reconnaissance of Jerome District."

ered underground should be followed as they have been found in practice to lead to orebodies."

Rock Types

(1) *Andesite Porphyry*

This name as used here includes the variety sometimes referred to as diorite porphyry. In the hand specimen, this rock is typically fine-grained, of a dark green color, veined with carbonate and chlorite, and showing general chloritization. In thin section, it is seen to be an andesite of diabasic structure, with the feldspars very much crushed and sheared (Fig. 1). Hydrothermal alteration has partly converted

Fig. 1. Fig. 2.

Fig. 1.—Andesite porphyry, showing crushed character of rock. Light gray minerals are feldspars, dark gray is chlorite. Ordinary light. Magnification, × 30.

Fig. 2.—Andesite porphyry, sheared and veined. Light gray, lath-like minerals are altered feldspars; dark gray is chlorite and serpentine. Large, light gray vein is of carbonate and quartz. Ordinary light. Magnification, × 30.

the feldspars to epidote, and changed the ferro-magnesian minerals to chlorite and serpentine. Fractures have been healed with carbonate and chlorite (Fig. 2), and some contain small pyrite cubes. Some specimens are coarse-grained, but in general the type is that of a small intrusive. The history indicated is one of not very deep-seated dynamic disturbance, followed by hydrothermal alteration with slight mineralization.

(2) *Schist*

Two types of schist were observed. In the hand specimen both were very fine-grained, dark green to grayish colored, with small, whitish patches somewhat sheared out.

The first type would be more properly classed with the phyllites. It

is an extremely fine-grained rock, now composed of an aggregate of quartz, chlorite, carbonate, and sericite, which has not been subjected to any very profound metamorphism. The shearing has developed abundant flakes of sericite but there has been no thorough reorganization of the material, with development of the high-density minerals. Later cracks are healed with carbonate, and some specimens show tiny disseminated grains of pyrite. The history of this rock is essentially the same as that of the

FIG. 4.

FIG. 3.—SCHIST. AGGREGATE OF SECONDARY MINERALS. LIGHT GRAY STREAKED PATCH IS SERICITE; LIGHT GRAY GRAINS ARE QUARTZ. CROSSED NICOLS. MAGNIFICATION, × 30.

FIG. 4.—SCHIST, APPARENTLY FORMED FROM IGNEOUS ROCK. LIGHT GRAY PATCHES SUGGEST FELDSPAR PHENOCRYST; WHITE, CRUSHED FRAGMENTS ARE QUARTZ; BLACK CUBES IN VEINLET ARE PYRITE. ORDINARY LIGHT. MAGNIFICATION, × 30.

andesites. It was originally a fine-grained fragmental, possibly a shale, but more likely, in view of its associations, an ash.

The second type is similar in composition and mineral make-up, but was formed by the more intense shearing of coarser material (Fig. 3 and 4). Grains of original quartz and scattered dense sericitic and chloritic patches, such as would result from the alteration of feldspar and hornblende crystals, suggest that the original rock was an igneous type, but it has been so much sheared that nearly all the primary structure has been obliterated and the determination of the origin is uncertain. The rock may have been a tuff formed from small rock fragments.

(3) *Quartz Porphyry*

In the hand specimen, this rock is of a gray-green color, fine-grained, with large quartz phenocrysts, and occasional red and green patches of feldspar and chlorite. Under the microscope, it is seen to be a very siliceous quartz porphyry with abundant quartz phenocrysts and an

occasional striated feldspar (Fig. 5). The groundmass is typically a very fine intergrowth of quartz and feldspar, so that the rock is of the type known as graphophyr, characteristic of small intrusions from a siliceous magma. The feldspar is partly altered to sericite, epidote,

Fig. 5. Fig. 6.

Fig. 5.—Quartz porphyry showing crushed quartz and feldspar phenocrysts and fine-grained groundmass. Crossed nicols. Magnification, × 30.

Fig. 6.—Quartz porphyry showing fractured feldspar phenocrysts veined with carbonate. Crossed nicols. Magnification, × 30.

Fig. 7.—Quartz porphyry, showing pyrite cubes (black) in veinlet cutting rock. Ordinary light. Magnification, × 30.

and carbonate (Fig. 6), and the original small ferro-magnesian content is now in the form of chlorite. Chlorite is also developed in the sheared zones, and seems here to be a vein mineral. These porphyries, as might be expected of a series of small intrusions, are somewhat variable in composition and habit. They also show different amounts of dynamic disturbance. Some show no trace of fracturing, while others have quartz,

chlorite, and carbonate veins and crush effects in the phenocrysts. Most of the specimens contain pyrite in the veins (Fig. 7); some as perfect cubes and some as crushed fragments. Black rims on the pyrite result from secondary processes.

The quartz porphyries, then, were intruded during the closing stages of the regional disturbance, and also after movement had stopped. The mineralization follows fractures in the porphyry and therefore is later in each case than the rock in which it is found, but is not necessarily later than the entire porphyry series, so that ore may be found cutting the dikes, and likewise dikes cutting the ore.

Ore Specimens

In addition to the wall rocks, some ore specimens, (1) and (2) from the United Verde, and (3) and (4) from the United Verde Extension mines, were examined microscopically. Unfortunately, all the material at hand was of the high-grade ore, so that the process of mineralization could not be studied.

United Verde Ore

1. The ore consists of bands of crushed pyrite and of sphalerite, the whole specimen veined and partly replaced by covellite (Fig. 8).

Fig. 8. Fig. 9.

Fig. 8.—Massive United Verde ore. Dark gray, rough, crushed mineral is pyrite; light, smooth mineral is sphalerite. Covellite cannot be distinguished from sphalerite in photograph. Reflected light. Magnification, × 34.

Fig. 9.—United Verde Extension high-grade ore. Gray, rough mineral is pyrite; gray, smooth mineral is quartz; smooth, white matrix is chalcocite. Reflected light. Magnification, × 34.

A very small amount of chalcopyrite appears in the sphalerite, and chalcocite is entirely absent. The banding may be due to replacement preserving the structure of a schist, or to deposition along the weaknesses of a sheared rock; probably the former, as it is quite fine and regular

The crushing of the pyrite appears to be a result of continued movement parallel to the schistosity. This is regarded as additional evidence that the mineralization began before the conclusion of the dynamic modification of these rocks. The covellite belongs to a different and later period, as it occurs in veinlets cutting the original structure and independent of it.

2. This ore is more massive pyrite, considerably crushed but not banded, containing chalcopyrite interstitially and in veinlets. An occasional large grain of chalcopyrite is in primary relation to the pyrite, so that it would appear that the chalcopyrite is, in general, later than the pyrite, but that some overlapping of these two constituents occurred.

United Verde Extension Ore

3. This is a massive pyrite with secondary chalcocite in veinlets, interstitially and in occasional large grains. The chalcocite is thus in the same relation to the pyrite as the chalcopyrite is in specimen (2), and is most likely the result of secondary enrichment (replacement) of the chalcopyrite. It has not at all the distribution to be expected if it were an enrichment of the original pyrite.

4. This ore is made up of small crushed pyrite remnants in a matrix of secondary chalcocite, and represents almost the final stage of the enrichment process (Fig. 9).

Summary

A general summary would be somewhat as follows: A complex of tuffs, dikes, flows, etc., not very deeply buried, was intruded by diorite and the whole subjected to regional metamorphism, developing schistose and crush rocks of great variety. At the closing stages of the metamorphic period, intrusions from a deeper-seated, very siliceous magma cut the older rocks. The same paths of weakness were followed by the mineralizing solutions, which were high in silica and replaced the wall rocks extensively. The abundant chlorite and sericite, and absence of the pneumatolytic minerals, such as tourmaline, would class this deposit with the intermediate-temperature type described by Lindgren.

The primary ore minerals observed were pyrite, chalcopyrite, and sphalerite. Secondary enrichment has converted the chalcopyrite and part of the pyrite to chalcocite. The covellite is probably secondary.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

The Economic and Geologic Conditions Pertaining to the Occurrence of Oil in the North Argentine-Bolivian Field of South America

BY STANLEY C. HEROLD,* PITTSBURGH, PA.

(New York Meeting, February, 1919)

CONTENTS

Introduction

Considerable interest has been shown, during recent years, in the possibilities of developing oil fields in the South American Republics, now that the exhaustion of our present fields can be seen in the not very distant future. The demand for fuel oil and its products has been increasing far more rapidly than our increment of production during the last few years. Increase of consumption has been largely curtailed by the lack of sufficient supply.

The main factors that have contributed to our previous neglect of the southern fields have been as follows:

(*a*) Lack of sufficient demand for the product.

(*b*) Competition with producing fields, having large production, low cost, and better geographical position, such as Tampico, Mexico.

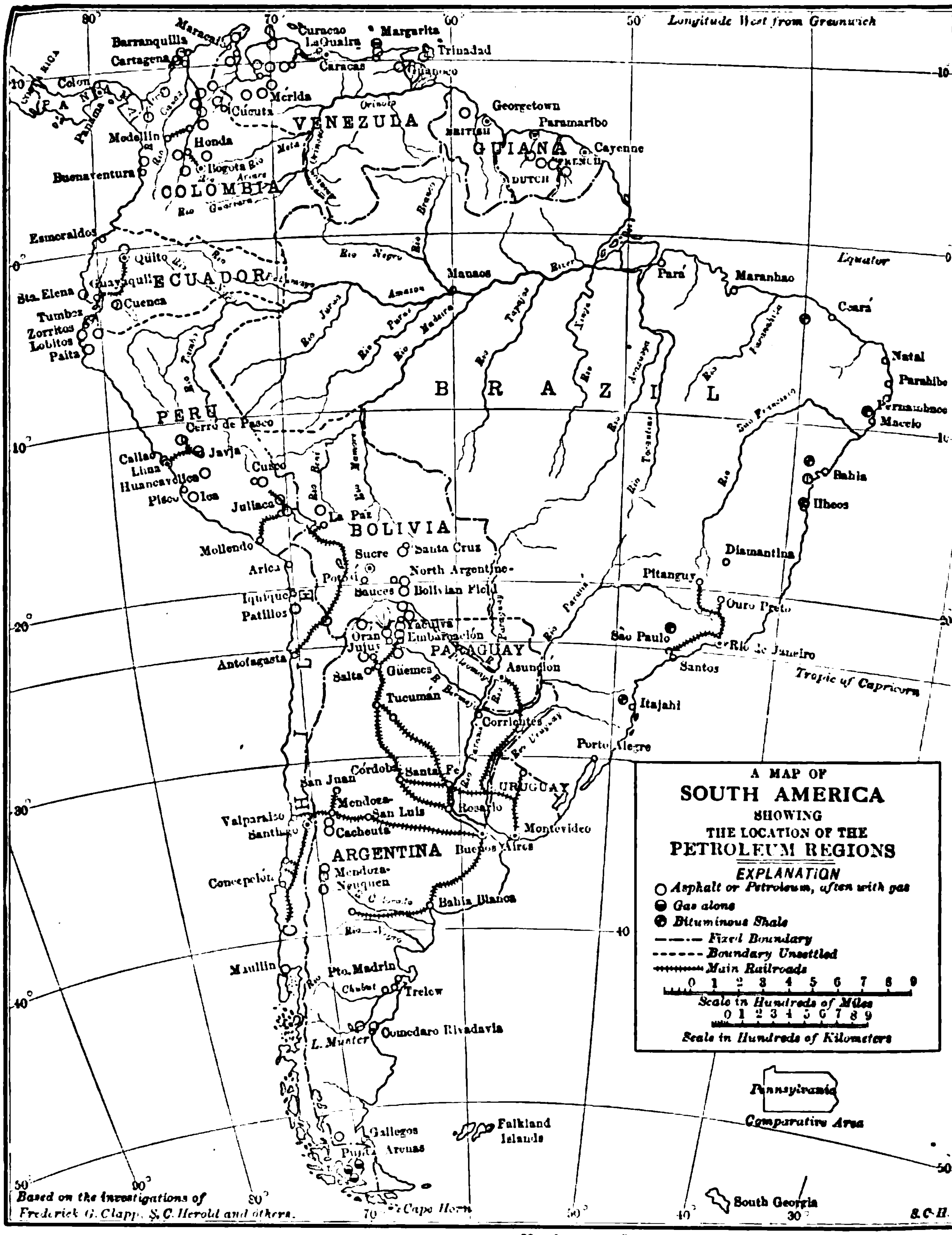
(*c*) Greater interest in home fields with ready market at hand.

(*d*) Our ignorance of southern economic and geologic conditions, due to the distance between those areas and our financial centers.

(*e*) Economic conditions in the southern countries, necessitating high costs of exploration and exploitation of the fields.

* Consulting Oil Geologist.

(*f*) Our lack of understanding of the business methods of the Latin-American.



Map Outline by Courtesy of Mathews-Northrup Works, Buffalo, N.Y.

FIG. 1.

It must be borne in mind that the oil-development work done to the present time in South America has, with one exception,* been undertaken

* The accidental discovery of oil in boring for water at Comodoro Rivadavia, Argentina.

upon lands which possessed direct evidence of oil in seepages or asphaltic deposits, occurring either immediately upon the lands or in their close vicinity. The development of oil fields in South America is therefore in the pioneer stage. It is not at all improbable that "hidden fields" will be uncovered in future work, as has occurred notably in the Mid-continental field of this country within recent years.

Location

The areas grouped as a unit under the title of North Argentine-Bolivian oil field extend in a narrow belt from the north-central part of the Province of Salta, Argentina, northward into the central part of Bolivia. This belt lies in a direction a few degrees east of north, slightly curved with its concave flexure to the west, passing through the border town of Yacuiva at latitude 22° South and longitude 63° 30′ West of Greenwich. It extends from 18° South to 23° South latitude.

To the west of the field lie the frontal ranges of the Andes System, beyond which extend high rugged mountains, deep narrow gorges and high plateaus, culminating in the crest of the continental range. Toward the east extends the great expansive plain, reaching over northeast Argentine, southeast Bolivia, northern Paraguay, and into southern Brazil.

Notable seepages of oil occur in the following political subdivisions of the two countries:

Argentina:
- Department of Orán, Province of Salta.

Bolivia:
- Department of Tarija.
- Department of Sucre (Chuquisaca).
- Department of Santa Cruz.

The location of this field has given rise to the name of "Sub-Andean Petroliferous Zone," a term used by some writers.

Literature

The literature on the oil regions of South America is very limited, particularly that in the English language. A résumé has recently been compiled in a valuable paper by Frederick G. Clapp.[1]

As to the literature in the Spanish language, among the most important publications are the reports of Dr. Guido Bonarelli,[2] of Buenos Aires,

[1] *Trans.* (1917) **57**, 914.

[2] *a*, G. Bonarelli: Las Sierras Subandinas del Alto y Aguaragüe y Los Yacimientos Petroliferos del Distrito Minero de Tartagal, Provincia de Salta. *Republica Argentina. Anales del Ministerio de Agricultura Sección Geologia, Mineralogia y Minera* (1913) **8**, Núm. 4.

b, La Estructura Geológica y Los Yacimientos Petroliferos del Distrito Minero de Orán, Provincia de Salta. *Ministerio de Agricultura Dirección General de Minas* (1914). Núm. 9, Ser. B.

who, as government geologist, has made diligent study of many petroliferous areas in his country and in southeastern Bolivia. Chemical analyses of the Sub-Andean petroleum have been made by Dr. Ernesto Longobardi.[3] Reports of Bodenbender[4] and Brackebusch[5] give valuable information regarding the geology of adjoining regions in the provinces of Salta and Jujuy. Steinmann[6] has made examination of the Sierra de Aguaragüe region, particularly in southeastern Bolivia. All the above reports have been freely consulted in the preparation of this paper.

Nomenclature

Some ambiguity apparently exists among references to the North Argentine-Bolivian region, due to varied spelling and multiplicity of names for the same locality. The following corrections and correlations are given with the hope of clarifying such ambiguities:

Capiazuti Wells.—Situated 4 miles (6.4 km.).northwest of the village of Aguaray. They are in Argentina, on Capiazuti Creek, 25 miles (40.2 km.) south of the Bolivian border. These wells are sometimes referred to as "Las Minas de Aguaray." Not to be confused with Cuarazuti.

Iquira Springs.—Seepages 2 miles (3.1 km.) south of Capiazuti, on Iquira Creek. Often included in the term "Las Minas de Aguaray."

Tartagal Wells.—Situated 3½ miles (5.6 km.) southwest of the village of Tartagal, Department of Orán, on Galarza Creek. Sometimes termed "Las Minas de Tobar," or "Las Minas de Tartagal."

Ipaguazu Springs.—Seepages of petroleum on Agua Salada Creek, 12 miles (19.3 km.) east-northeast of Yacuiva. Synonymous with "Lomas de Ipaguazu." Included in the "Gran Chaco" seepages. Incorrectly written Ipaguaciu or Ipahuaso.

Yacuiva.—The Bolivian frontier town, though 2 miles south of the border recognized between the two countries; viz., 22° south latitude. Also correctly written Yacuiba, but incorrectly Ayacuiba.

Aguaragüe.—The frontal range of mountains commencing a few miles southwest of Tartagal, extending northward into Bolivia. Sections of the range are sometimes designated, "Cerros de Tartagal," "Cordon de

---

[3] Los Petróleos Subandinos y sus relaciones Geo-químicas. *Anales de Sociedad Química Argentina* (1915) **3**, 423.

[4] Informe sobre una exploración geológica en la región de Orán (Provincia de Salta). *Ministerio de Agricultura Boletín* (1906) **4**, Núm. 4, 5.

[5] Brackebusch: Estudios sobre la formación petrolífera de Jujuy. Boletín de la Academia Nacional de Ciencia de Córdoba (1882) **5**, 137–252.

[6] *a*, G. Steinmann, H. Hoek and A. V. Bistram. Zur Geol. des sudöstl. Boliviens. Tentralbl. für M. G. u P., Stuttgart, 1904.

b, H. Hoek and G. Steinmann: Erläuterung zur Routenkarte der Exped. Steinm. Hoek, V. Bistram in d. Anden v. Bolivien. *Petermans Mittheilungen* (1906) **1**.

Itaque," etc. The northern extension comprises the "Sierras de Santa Cruz." Improperly written Aguaraygus, Aguaraygua, etc.

Cuarazuti.—A creek in the Department of Tarija, Bolivia, north of Yacuiva. Incorrectly written Guarazuti or Kuarazuti.

Gran Chaco.—The great plains extending over northern Paraguay, southeastern Bolivia and northern Argentina. The Province of the Gran Chaco of Bolivia includes the eastern parts of the departments of Tarija and Sucre (Chuquisaca). Geographically divided into Chaco Oriental or Chaco Paraguayo, Chaco Central and Chaco Austral, the latter two largely included within the boundary of Argentina.

Topography

The North Argentine-Bolivian oil region lies along a boundary line between rough mountainous country to the west and extensive plains to the east. A series of mountain ranges, with parallel trend from north to south, stretches westward with increasing altitude until the crest of the great Andes Range is reached. Between these ranges are long narrow river valleys with occasional river terraces, which frequently serve as locations for villages at altitudes varying from 10,000 to 12,500 ft. (3048 to 3810 m.) above sea level.

The entire mountainous relief has been produced by the same dynamic forces which caused the uplifting of the main Andes Range, modified by subsequent weathering and stream erosion. The easternmost range, known as the Sierra de Aguaragüe, with its northern extension in the Sierras de Santa Cruz, constitutes the frontal range, extending from north to south for a distance of approximately 300 miles (483 km.), with altitudes between 1000 and 3000 ft. (305 and 914 m.) above the level of the adjoining plains.

Extending eastward from the frontal range lie the great plains (El Gran Chaco) of northern Argentine, southeastern Bolivia, northern Paraguay and adjoining parts of Brazil. With a slight inclination to the southeast, they stand at elevations varying from 1600 ft. (488 m.) in the south to 2400 ft. (732 m.) above sea level in the north. Slight vertical displacement has apparently taken place in various sections of the plains, as is shown by the flexures in the stratified deposits of Quaternary age. This movement has caused a distinct topography of low rolling hills, partially eroded by subsequent torrential stream water. Typical of this topography are the hills 6 miles (9.6 km.) to the northeast of Aguaray, and also the hills of Ipaguazu northeast of Yacuiva. They stand between 200 and 300 ft. (61 and 91 m.) above the surface of the plains.

Numerous small streams flow from the deep narrow gorges in the mountains and enter upon the plains with slackened gradient. Most

of these proceed for only a few miles, as they lose themselves in the deep loose sand deposits so frequent and extensive in the flat country. Where the water has the opportunity to collect in volume before leaving the rocky beds in the mountains, more persistent streams flow with a southeasterly course and find their way eventually to the Paraguay River. Thus it is with the Pilcomayo and Bermejo Rivers.

The extreme northern end of the region is within the water-shed of the Amazon River, through the successive tributaries Río Grande, Río Mamore, and Río Madeira.

Climate

The climate of this region is subtropical, with temperature variation between 40° F. in winter to 90° F. in summer. Occasionally more extreme temperatures of 30° and 115° are experienced, though generally for short duration only. The humidity of the summer atmosphere is rather oppressive, and rainfall at this season is heavy. The winter months are rainless, to such an extent that resident natives suffer from lack of good water for domestic purposes. As the region is south of the equator, the seasons are the reverse of those in the northern hemisphere.

It is during the summer months that the great migration of insects and animals takes place from the tropical jungles in the north. The most conspicuous insects are the mosquitoes, flies, and grasshoppers. There are several varieties of flies that are inconvenient, but their bite, fortunately, is not serious. Some malaria exists, though it is not at all so common as in the tropical countries. On the whole, very little sickness prevails, so the region may be classified as a healthy one.

The great pest of the country is the grasshopper, *longosta*, flying from the north in hordes of millions, destroying all vegetation which may happen to lie within their path. No satisfactory method of combating them has yet been discovered. Several plans are now under investigation and experimentation.

Inhabitants and Industries

The inhabitants may be divided into three groups: Saltanean, Bolivian, and Indian. In addition to these are found a very small proportion of foreigners, such as Spanish, English, Italian, Syrian, French, and North American.

The Saltanean of high class is of Spanish descent, proud, aristocratic, courteous, alert and prosperous, possessing these qualities perhaps to a higher degree than most other natives encountered by the writer in his travels south of the Canal. He has distinguishing characteristics in customs and language that are readily recognized by Argentinos from other regions. The laboring or peon class has a considerable admixture

of Indian blood, and they make faithful and trustworthy workers. Wages are standardized at one peso (44 c. gold) per day.

The high-class Bolivian differs little from the Saltanean. He shows, however, a greater proportion of Indian blood as a rule, in having a darker skin. Peon classes of both countries have wandered across the boundaries to some extent; this cannot be said of the higher class.

Here is the home of the Chiriguano and Mataco Indian. Both retain most of their tribal customs, though the former has undoubtedly advanced by his contact with civilization. The Chiriguano lives in houses equal to those of the civilized peon and he himself is quite trustworthy. The Mataco, however, is more deceitful and dishonest. He will kill to steal if he feels assured that he will not be apprehended. As he has no permanent abode he wanders by groups or families, and camps by the roadside where the close of day may chance to find him. Both tribes, men, women and children, are employed as cane cutters during the sugar harvest, their employment being arranged for in advance by the planter's traveling agents.

The raising of sugar, corn and cattle constitutes the chief occupation of the people. While most of the mountainous regions are uninhabited, the valleys and plains are well utilized in cultivation or grazing. As a rule, the plantation and cattle owners live in the towns and cities and leave the property in charge of trusted employees. Some enterprises are run on an extensive scale, notably the sugar plantations with large refineries under the same management. Thousands of acres of land are devoted to this product.

The custom of living in small villages is very popular with the poor native. Every few miles has its group of houses ranging in size from 3 to 50 habitations. By so living the social tendency is satisfied and the native need not be far from his work.

Timber

A large portion of this section of the country is covered with timber, especially in the mountains. True tropical jungle does not exist in the south, due to the low winter temperatures. As one travels toward the north, however, a gradual change in the nature of the forest growth is noted, the softer woods of the south being replaced by the more valuable hard woods. Palms also become more conspicuous toward the north.

Approach and Accessibility

The terminal at the town of Embarcación, in Argentina, is the nearest approach made by a railroad to the oil region. This road is a narrow-gage line operated under the management of the "Ferrocarril Central

Norte," connecting the cities of Tucumán, Salta, and Embarcación, with a junction point between the latter two at Güemes. The broad-gage line of the company "Ferrocarril Central Argentina" connects Tucumán with Buenos Aires.

Another approach to the field is by way of Asunción, the capital of Paraguay, which is directly connected by rail with Buenos Aires. The distance from Asunción to Yacuiva is approximately 455 miles (732 km.) overland, whereas Embarcación is but 114 miles (183 km.) Furthermore, Asunción is on the opposite side of the Río Paraguay from the field; the river at this point would be difficult to bridge.

Over the route to Embarcación, through passenger express service runs twice weekly between Buenos Aires and Salta, with direct connection at Tucumán. The trains carry sleeping and dining accommodations and the trip requires 36 hr. to Salta. Between Salta and Embarcación there is daily service by slow train, requiring 14 hours.

As for freight service, considerable time is consumed and expense incurred by the necessary transfer of material from cars of one gage to those of the other at Tucumán. Rates at present are high.

Rail distances between points are as follows:

Buenos Aires to Tucumán	1344 kilometers	(835 miles)
Tucumán to Güemes	294 kilometers	(182.6 miles)
Güemes to Salta	46 kilometers	(28.6 miles)
Güemes to Embarcación	223 kilometers	(138.2 miles)
Buenos Aires to Embarcación	1861 kilometers	(1155.8 miles)

No Bolivian railroads reach the interior from the direction of La Paz; therefore this route is impossible as an approach for freight.

Away from the railroad lines, freight is carried by two-wheeled carts. There is considerable traffic between points in Argentina and Bolivia over the road leading northward from Embarcación. This road, in the dry season, is in bad condition, and worse in the wet season, when it becomes impassable. The river crossings are heavy, due to deep loose deposits of sand in some and large boulders in others. Weak bridges span the narrower gullies in some parts.

Sand areas are so numerous on the flat plains that the road must cross some of them. The clay sections of the road are very badly rutted by the heavily laden carts.

An extension of the railroad from Embarcación would represent a simple engineering problem.

The Pilcomayo and Bermejo Rivers have beds about 400 ft. (122 m.) wide from bank to bank. Between these banks the stream meanders from one side to the other, though on occasions of excessive rainfall, the entire bed may be covered. These streams can not be reckoned on for transportation.

The Paraguay River, with the Paraná, into which the former empties,

is navigable throughout the year. River boats drawing from 4 to 6 ft. ply regularly between Asunción and Buenos Aires, a distance of approximately 745 miles (1200 km.). The river is a free trading route and would, therefore, possess that advantage over the rail to Buenos Aires. As above stated, the distance between the field and the river at Asunción is approximately 455 miles (732 km.).

Oil Seepages

Seepages of oil, and asphalt deposits, have been known to exist in this part of the continent for many years. The native Indians had used it for medicinal purposes and knew of its inflammability before the arrival of the first Spanish explorers. To this day, small quantities are collected by both Indians and civilized people for domestic use, as the oil is often of such high quality that it may be used in crude lamps in its natural state.

Several springs are very persistent in their flow, though they give only two or three quarts, individually, per day. Among the best known are the following, named in geographical order from south to north:

Name of Creek	Location
Galarza	Department of Oran (Argentina)
Iquira	Department of Oran (Argentina)
Agua Salada (Ipaquazu)	Department of Tarija (Bolivia)
Los Monos (Villamontes)	Department of Tarija (Bolivia)
Caigua (Villamontes)	Department of Tarija (Bolivia)
Peima	Department of Tarija (Bolivia)
Oquita	Department of Sucre (Bolivia)
Mandiyuti	Department of Sucre (Bolivia)
Espejos (Santa Cruz)	Department of Santa Cruz (Bolivia)

With the exception of the Agua Salada spring, the seepages lie along a north-south line bordering the eastern flank of the Sierra de Aguaragüe, between Galarza Creek, near Tartagal in Argentina, and Espejos Creek, near Santa Cruz in Bolivia. The springs occur in creek beds, where the flowing water keeps the rock surfaces clean and does not allow the heavier residue from evaporation to clog the pores.

In addition to the above springs, numerous other localities have been reported by competent natives to show signs of oil. These are also in creeks crossing the same line, and are said to show oil on the surface of quiet water before the drying-up of the streams. During the dry season the oil can sometimes be detected by odor from fresh soil at these places. Among such creeks are the following:

In Argentina: Zanja Honda, Yeriguarenda, Yacuy, Piquirenda, Ñacatimbay, Capiazuti, Carapari (Itiyuro). In Bolivia: San Roque (?), Caipitandé, Cuarazuti.

In order to collect the oil, the natives have sunk small pits, not over 1 cu. ft. in size, over the place where it comes to the surface. Some water also collects, but the oil is easily skimmed off the top.

Quality of Oil

There is considerable range in the quality of oil coming from the various springs. In general, the springs may be divided into two groups according to the weight of the oil. The light oils are of light yellow or

FIG. 2.—SEEPAGE OF OIL ON THE BANK OF GALARZA CREEK.

orange color, with greenish fluorescence, and vary in gravity between 41° and 46° Baumé. Heavier oils are of deeper colors, reddish-brown to almost black, and also fluorescent; their gravity varies between 20° and 27° Baumé.

Dr. Longobardi gives the results of tests (Table 1) performed upon samples, the naphth acontents of which had been slightly reduced by evaporation at the springs.

Samples from the Agua Salada and Espejos springs, which have been sent to the United States, have sometimes been prematurely discredited on account of their apparent high gravity.

Most of the oils are of paraffin base, though some of the heavy ones contain some asphalt. Usually a small amount of sulphur is present.

TABLE 1.—*Results of Tests on Samples from Some of the Springs*

Locality	Color	Gravity at 15° C.	Fractional Distillation		
			Begin at	To 300° C., Per cent.	Over 300° C., Per cent.
Light Oils:					
Agua Salada	Amber	45° Bé	153° C.	91	9
Los Monos	Reddish	42	160	78	22
Caigua	Orange	41	158	79	21
Espejos	Orange	46	154	78	22
Heavy Oils:					
Galarza	Dark brown	23	195	15.5	84.5
Iquira	Brown	20	235	11	89
Peima	Brown	26	152	31	69
Oquita	Dark brown	27	180	41	59
Mandiyuti	Red-brown	26	178	31	69

All show greenish fluorescence. Distillation test by Engler method.

DEVELOPMENT

The results of the development attempted in the past have been unsatisfactory, principally due to the lack of sufficient knowledge on the part of the operators concerning the stratigraphic and structural conditions existing in the field. Wells have been placed in localities where there would seem to be no possibility of reaching the oil horizons which are in evidence on adjoining ground, and where local structural conditions are not particularly favorable for the accumulation of petroleum below the surface. Obviously, such wells are unable to give definite proof regarding the possibilities of the field at large.

Other enterprises have failed on account of financial difficulties, lack of proper organization, or mismanagement. A company intending to work in this field should have sufficient capital to tide it over excessive costs before expected returns. A well of 3000 ft. (914 m.) depth may be calculated to cost between $65,000 and $75,000. Transportation and imported labor are expensive, and delays are frequent notwithstanding the large quantity of spare parts necessarily required. Drillers must be carefully selected. Proficiency does not seem to be a more important qualification than personality and adaptability, for in camp the companionship must be agreeable and modern conveniences are generally absent.

Although thousands of claims have been legally granted by the governments of Argentina and Bolivia, only seven or eight honest attempts have been made to develop various sections of the field. The most conspicuous work has been that done on the Galarza, Capiazuti and Mandiyuti creeks. A brief discussion of these follows.

Galarza Creek

The work on Galarza creek was started by Señor Francisco Tobar in 1907. The presence of two natural seepages of oil induced him to sink several pits by hand in the creek bed and on the banks above. He invariably encountered a soft porous sandstone, so saturated that the oil collected in the bottom of the pit. He secured two portable rigs of 1000-ft. capacity and sank four wells. Dr. Bonarelli gives the following data regarding these wells:

Well No. 1.—Depth reached 188 m. (617 ft.). Encountered two strata with petroleum; the first at 70 m. (230 ft.), the second at 140 m. (460 ft.).

Well No. 2.—Depth reached 241 m. (838 ft.), encountering five strata bearing oil. (Showings.)

Well No. 3.—Depth reached 75 m. (246 ft.); nothing encountered.

Well No. 4.—Depth reached 39.5 m. (130 ft.), encountering oil-bearing sand from 37 m. (121 ft.) downward, and at 39.5 m. a surging spring of gaseous water with taste and odor of petroleum.

Thus the drilling was unsuccessful. Nothing more than a show of oil was encountered below the original oil-bearing strata exposed in the creek bed below the well locations.

Capiazuti Creek

Drilling at the side of Capiazuti Creek was encouraged by the presence of the oil springs on Iquira Creek, two miles to the south. With these springs the two wells drilled here were evidently located by "topographic correlation" for they are poorly located with respect to the stratigraphic and structural conditions of the immediate vicinity.

The first well was landed at 240 m. (787 ft.) with 4-in. casing, encountering nothing, and was abandoned on account of the small diameter at that depth. The rig was moved westward about 15 m. and landed at the same depth with 10-in. casing, when further work was postponed indefinitely.

These holes have been sunk since early 1912 under the management of the "Dirección General" of the Argentine Government. The rig was imported from Holland and has a capacity of 750 m. (2460 ft.). The derrick is entirely of steel and stands 85 ft.

This same rig had previously been used (1910–1911) in drilling two dry holes outside of the Capiazuti canyon. One was located 1 km. east of the Iquira springs, and the other 2 km. still farther east, in the village of Aguaray. The first hole reached a depth of 133.6 m. (438 ft.), encountering only water at 128.2 m. (420 ft.). The second hole was abandoned at 46.6 m. (153 ft.) on the advice of Dr. Bonarelli.

Mandiyuti Creek

In 1911–12, the Farquhar Syndicate, organized for the apparent purpose of acquiring title to many of the largest Argentine and Bolivian enterprises, obtained petroleum concessions on Mandiyuti Creek, in Bolivia. A complete outfit was imported at Buenos Aires, shipped to Embarcación and hauled by mules a distance of 225 miles.

FIG. 3.—STEEL DERRICK ON CAPIASUTI CREEK.

One well was drilled to a depth of 157 m. (515 ft.), encountering a considerable showing of oil at 505 ft. Drilling ceased, and soon after the syndicate went bankrupt.

It is interesting to note the difference between the analyses of samples taken from the springs and from the hole.

From Springs:
- Color: Reddish brown, with greenish fluorescence.
- Density: 26° Baumé.
- Distillation test (Engler method):

From 178° to 300° C	31 per cent.
Residue, over 300° C	69 per cent.

From Drill-hole:
- Color: Amber, with light greenish fluorescence.
- Density: 38° Baumé.
- Distillation test (same method):

From 70° to 150° C	18.0 per cent.
From 150° to 300° C	40 0 per cent.
Residue, over 300° C	42.0 per cent.
Paraffin residue, sulphur content	0.129 per cent

In general, the oil encountered at depth may be expected to be of higher quality than that seeping at the surface in other parts of the field.

Geological Conditions

Stratigraphy

The surface of the oil region is entirely covered by sedimentaries. The only signs of igneous rocks are a few scattering fragments to be found

Fig. 4—A view of the Sierra de Aguaragüe, in Bolivia The Sub-Andean Tertiary series is shown along the crest.

in the creek beds, which have evidently been transported from the higher mountains of the Andes Range to the west. Such transportation took place previous to the late diastrophism which gave rise to topographic

features now eroded to their present condition in this "Sub-Andean" province.

The stratigraphy of this area has been a subject of discussion for some years past by the geologists who have worked here or in close vicinity. Fossil remains have been found in but one horizon sufficient to classify its age. Other strata covering the greater part of the area are apparently non-fossiliferous, for diligent search has failed to produce specimens. Consequently, classification has largely been based upon correlation of strata and comparative lithology.

The recent work of Dr. Bonarelli has established the correctness of the stratigraphic interpretation previously given by Steinmann and Bodenbender, though Bonarelli has proceeded farther in differentiation by subdividing the groups formerly recognized.

Bonarelli's divisions of the Aguaragüe formations are as follows:

(*f*) Recent alluvial.
(*e*) Quaternary.
(*d*) Sub-Andean Tertiary.
(*c*) Upper sandstone (*Areniscas superiores*).
(*b*) Calcite-dolomite horizon.
(*a*) Petroliferous formation, or lower sandstone.

The Petroliferous Formation

The term *Formación Petrolífera* was first used by Brackebusch in his early studies of the northern Argentine provinces. He later designated the series "Salta Series" (*Sistema de Salta*) obviously with the same stratigraphic limits as signified by the first name. This series is divided by Bonarelli into *a*, *b*, *c*, and *d* above, the term *Formación Petrolífera* being retained by him for the present recognized oil-bearing series. Steinmann, who had worked in the north around Santa Cruz, had designated the series of sands and shales underlying the calcite-dolomite horizon as the "Lower Sandstone" (*Areniscas Inferiores*).

This series is composed of a succession of medium-grained sandstones with beds of laminated or massive shale. The sandstone is generally massive, though sometimes thinly bedded, of medium harness, and gray in color. Crossbedding is shown in a few localities. The shale is hard, compact and of bluish-gray color; the thinly laminated beds often contain considerable sand. The color of both sandstone and shale shows alteration to yellow or brown on the surfaces exposed to the weather. Occasionally marl in thin bands, and also conglomerates are present.

Bonarelli estimates the total thickness of the series to be over 6000 m. (19,600 ft.) though it is possible that he has measured beds repeated by folding and faulting. There can be no doubt, however, of the first 2000 meters.

Respecting the age of the formation, the same author is of the opinion that it is Jurassic, and possibly older. Steinmann and Bodenbender considered it Cretaceous. The preponderance of evidence seems to support the latter view. Future work may reveal its age with precision, provided that fossil remains are found in the beds.

The *Formación Petrolífera* is not only the core of the entire Sierra de Aguaragüe range, but also underlies the young deposits of the plains stretching toward the east from the mountains. The oil seepages of this area, and also others beyond this belt to the west and southwest, not included within this paper, are intimately associated with this formation. The exposed strata from which the Agua Salada oil is flowing are probably of the same age and possibly of the same series. Correlation is impossible, however, until fossils can be found, for the intervening surface between Agua Salada and the Sierra de Aguaragüe is completely covered by Quaternary deposits.

This formation appears to be the basal series of the region. There has been, as yet, no recognition of an older series to the northeast of the province of Tucumán.

The Calcite-dolomite Horizon

Steinmann and Bonarelli have both recognized the series *Horizonte calcáreo-dolomítico* in the northern and southern divisions of this region, respectively, overlying conformably the petroliferous formation. It is described by the latter as follows: "A thin formation of calcitic and dolomitic strata with rare intercalations of other lithologic types; white or reddish, beds of variable thickness, very compact, with amorphous structure, conchoidal fracture, frequently with bands or nodules of jasper."

Steinmann places the age of this horizon as Cretaceous, on the evidence of fossils which he encountered within the formation. The thickness of the beds varies from 2 to 15 ft. (0.6 to 4.6 m.). While it is considered a persistent stratum, it is sometimes difficult to recognize, possibly because of local variations in character or on account of the ease with which it may be covered from view by débris.

The Upper Sandstone

The calcite-dolomite horizon is overlain unconformably by the Upper Sandstone (*Areniscas superiores* of Steinmann and Bodenbender). This series is non-fossiliferous and is composed chiefly of sandstone and shale. Bonarelli describes it as follows: "This formation begins at the bottom with a series of strata mostly sandy and conglomeratic; overlain by a series of yellowish and whitish sandstones, by impure sandy marls,

and above this a series constituted by repeated alternation of soft sandstone reddish, yellowish and gray with marls and sandy or limey shales, more or less compact." The reddish and yellowish hues are due to weathering. The thickness of the entire series is approximately 600 ft. (183 m.)

The Upper Sandstone probably belongs to the Tertiary Epoch. Steinmann did not differentiate the specific groups which he found associated with petroleum but he stated that he believed them to be Cretaceous, with Tertiary possibly in the upper part.

Sub-Andean Tertiary

Dr. Bonarelli appears to have been the first to have differentiated the *Terciario subandino* series which overlies the Upper Sandstone with apparent conformity throughout the Aguaragüe region. The series consists largely of thickly bedded, fine-grained, white, soft sandstone, interbedded with soft, light-colored shales. Some shale beds contain a small amount of sand or lime material. No fossils have been found in the series.

This series is mainly of interest with respect to the topography of the area. It forms the crest of the Sierra de Aguaragüe and is subject to rapid erosion by mountain streams which consequently run in steep, narrow gorges. Along the top of the ridge, throughout the length of the range, the series is exposed in almost vertical cliffs from 300 to 700 ft. (91 to 213 m.) high. The entire thickness reaches over 6000 ft. (1829 m.).

Quaternary and Recent

The extensive *Chaco* plains are covered with loosely stratified, horizontal beds of sand, clay and gravel. This formation probably measures at least 400 ft. (122 m.) in thickness and has evidently been laid down upon previously peneplained surface of older rocks, including the *Formación Petrolífera*. In some localities the strata show slight flexures. A typical exposure can be seen at the Itiyuro Creek near the village of Campo Duran, to the northeast of Aguaray.

The recent alluvial deposits of loose clay, sand, and gravel, unstratified, have been laid down in various sections of the plains, especially along the foot of the range, by streams which are capable of carrying considerable detritus during the rainy season.

Structure

The regional structure, consisting of extensive thrust faults, anticlinal folds and synclinal folds, is not particularly difficult of interpretation and

is, therefore, comparatively well known. The local features often present more difficult problems, owing to the obscurity of the older strata under younger deposits and to the lack of good horizon markers in the various groups.

The great thrusts originating below the Pacific Ocean off the west shore of the continent have pushed up the Andes Range, a series of parallel mountain ridges extending from north to south, producing folding and faulting of the sedimentaries previously laid horizontally over the area. The effects of the major thrusts have been transmitted toward the east, and perhaps on account of a greater rigidity of formations at this latitude, the resultant disturbances stand out so prominently at the great distance from the axis of the major ranges.

The folding of the Sierra de Aguaragüe may not have been synchronous with the upheaval of the main range. The structural features of the Aguaragüe were produced at the end of the Cretaceous period, and smaller movements have probably taken place periodically since that time. This is, no doubt, the cause of frequent earthquakes in the region today.

A sketch map by Dr. Bonarelli, showing the structural features of the Argentine portion of the Sierra de Aguaragüe and adjoining territory to the east and west, is reproduced in Fig. 5.

The strong thrusts have upturned the petroliferous formation along the Aguaragüe Range so that they are now standing at 75° or higher, dipping east or west, with a strike of N. 10° E. Stresses have been greatly relieved by a series of thrust faults between the ranges to the west and along the eastern flank of the Aguaragüe. The frontal range does not mark, however, the eastern limit of the action of the thrusts, for there is evidence of steeply dipping strata underlying the Quaternary deposits of the Chaco plains, at least within a certain radius of the range.

The Sierra de Aguaragüe fault extends along the eastern flank of the range for almost its entire length. It plays the important rôle of aiding the petroleum to the surface at the numerous springs. In Argentine, the fault plane has a strike of approximately N. 20° E. and swings to due north in Bolivia. The dip is to the west, varying between 40° and 60°. A thrust displacement of over 1500 ft. (457 m.) has taken place.

The calcite-dolomite horizon accompanied the underlying formation in its distortions, as it had previously been deposited conformably upon them.

The upper sandstone series presents a different aspect from the lower strata. With a strike varying between N. 10° E. and N. 26° E., it has a westerly dip ranging from 3° to 30° in the south and north respectively. This formation is oil-bearing on Galarza Creek at the "Tobar wells." Migration has taken place from the older strata below.

The Sub-Andean Tertiary series has a strike conforming to that of the

upper sandstone, with a dip varying between 5° and 35°. This a younger groups have, so far as is known at present, no associatio petroleum.

FIG. 5.—DR. BONARELLI'S SKETCH SHOWING STRUCTURE IN THE ARGENTINE S OF THE NORTH ARGENTINE-BOLIVIAN FIELD.

During a period as late as the Pleistocene, the central part South American continent was covered by an extensive conti sea. In northern Argentine and southeastern Bolivia, the surfa been previously well base-leveled with but few, if any, places rem

of sufficient height to escape immersion in the Pleistocene sea. Later, the interior of the continent underwent gentle uplifting to its present level. The beds are not absolutely horizontal, however, as slight flexures, anticlinal and synclinal, have been observed to cover extensive areas.

Summary

Extending from northern Argentine northward into central Bolivia is a belt of petroleum seepages. On account of the remoteness of the district it has, heretofore, been little considered by oil operators. The regional geology is comparatively well understood but the local features have not been carefully detailed.

Development work in the past has been done on an unscientific basis and has led to failures. At the present time, access to the region is somewhat difficult but no serious problem would be encountered in improving the conditions. The nearest railroad terminal is at Embarcación, 114 miles (183 km.) south of the Bolivian border, or 72 miles (116 km.) from the nearest manifestation of petroleum in natural springs.

The oil is of high quality and the seepages occur in creek beds along the Sierra de Aguaragüe fault, and at other isolated places.

Native labor is good and government policies are sympathetic toward foreign exploitation.

Though the structural features of the region, as a unit, have been worked out by reconnaissance surveys, there still remain many local sections upon which no detail study has been made.

Several small areas have been proved unfavorable for production, though the region as a whole cannot be condemned on this account.

Recent Geologic Development on the Mesabi Iron Range, Minnesota

The following correspondence relating to a paper bearing the above title, presented by J. F. Wolff, at the New York meeting in February, 1917, and published in the *Transactions*, Volume LVI, page 142, has passed between the author of the paper, and Mr. Anson G. Betts, and is interesting, although it was received much too late for incorporation in its proper place in Volume LVI.

Anson G. Betts, Asheville, N. C.—1. I should like to ask Mr. Wolff if he finds from analysis of the iron formation and of the iron ore, and from the relative amounts of each in each unit area of the formation, unleached and after leaching, that the iron remains entirely insoluble and the total quantity still remains present; or whether he finds that some of the iron is removed, or possibly even added by deposition from the water passing through the formation.

2. The water that passed into the iron formation had to go somewhere; was it absorbed by underlying formations through hydration, or, after passing through the ore formation, did it come to the surface in springs at a lower elevation, or how did it escape from the ground?

3. I should like to ask Mr. Wolff whether he finds that the iron formation in the sedimentary series does not come next to the quartzites and generally between the quartzites and slates.

J. F. Wolff, Duluth, Minn.—1. In common with others, you appear to have some hesitancy in accepting the fact of the removal, by solution, of the enormous quantity of silica which has been leached out of portions of the Biwabik iron formation, thus forming orebodies of merchantable iron ore. I believe that even Dr. Waldemar Lindgren once hesitated to accept this fact. However, the evidence is so simple and absolutely conclusive that the fact is established beyond all question. At the contact of orebodies with their rock walls, the bands of iron ore in the orebody can be seen in contact with the corresponding bands of original iron oxide in the rock wall, and the chert layers in the rock wall can be seen to give place to fine granular material (fine silica and iron oxide) and pore space. This is especially noticeable where slumping at the rock walls has not been so great as to displace the layers in the orebody from their contact with their corresponding layers in the rock wall.

Although complete analyses of the entire original rocks in the iron series have not been made in any place, to my knowledge, from the best data at hand as to the average analysis of the Biwabik series and the corresponding average analysis of orebodies derived from them, I have computed that the total iron per unit of area has remained the same in

the orebodies as it was in the original rocks from which the orebodies have been derived. In other words, there has been practically no removal of iron, although of course secondary iron, principally in the form of the hydrated oxides, is found in nearly all orebodies.

2. Regarding the circulation of water in the ore formation, no theory need be advanced, for there are facts at hand which indicate quite certainly what that circulation was. In a series of articles published in the *Engineering and Mining Journal*, July 17 to August 7, 1915, you will find a great deal of information regarding the detailed geology and engineering practice of the Mesabi Range. In the issue of Aug. 7, 1915, you will find a diagram showing the probable circulation of water in the Biwabik iron formation, which circulation resulted in the development of orebodies. I have pointed out therein that drilling through the Virginia slate, which caps the Biwabik formation on the south, in several places has developed artesian wells, showing that water is imponded under the Virginia slate.

I have also pointed out that toward the south side of the outcrop of the iron formation many fissure orebodies have been found and individual drill holes have penetrated a large thickness of ore material of rather low grade, and that these fissure orebodies and isolated drill holes penetrating decomposed iron formation are the places where the underground water, which has effected the concentration of the orebodies, has risen again to the surface in an artesian circulation. Moreover, recent explorations have shown that the large trough orebodies become narrow toward the south, or Virginia slate, side of the outcrop, and these channels represent the lower ends of the artesian circulation. Furthermore, these channels contain ore or ore formation of a very inferior grade, as a rule, as compared with the ore in the larger or main orebodies farther up the dip of the iron formation. Of course these facts as to the original circulation of ground waters are not susceptible of absolute demonstration but rather are inferred from knowledge of character and structure of orebodies, and they are recognized as the most probable explanation of underground circulation in the iron formation by those best qualified to judge of them on the Mesabi Range.

I do not believe that the area was cut up extensively by erosion, because at the present time the local relief of the top of the iron formation is practically negligible. In other words, there are no marked hills and valleys such as would account for underground drainage. There has been a considerable amount of hydration, the average loss on ignition being perhaps 6 per cent. However, such hydration probably would result in throwing the silica out of solution and therefore we should have large amounts of secondary silica present in the orebodies. There is no great amount of secondary silica, so I conclude that the amount of water taken up in hydration of the ores is relatively very small as compared with the

amount necessary to effect the solution and transportation of the silica. Where the silica has gone to, of course, no evidence at hand tells, but we can only assume that it flowed out onto the surface at the point of discharge of the artesian water.

3. From what we know of the pre-Cambrian, Algonkian metallographic series of rocks in different parts of the world, I believe that most geologists who are familiar with these rocks will look for iron formation in any sedimentary rocks, whether they be slates, quartzites, or limestones, or any combination of these three which can be determined to be of Algonkian age. In other words, to answer your last question specifically, if I found quartzite and slate in an area of Algonkian rocks, I would examine the area closely for evidence of iron formation, because we know that, especially in North and South America and Africa, and probably in Eastern Asia also, iron formations occur in sedimentary series in pre-Cambrian, Algonkian rocks.

INDUSTRIAL SECTION

This department is devoted to material concerning the products or operations of manufacturers, which, in the estimation of the Editor, is of news value to the mining and metallurgical field, but does not come within the scope of the main editorial section of the Bulletin.

Manufacturers are invited to submit to the Editor items descriptive of new equipment or processes, large or significant installations, and similar material of news character. If found available, items thus furnished will be published in this section without charge, subject to such editorial revision and condensation as may be necessary.

In cases where illustrations are required, cuts of the proper size should accompany the text matter.

THE JEFFREY CARRIER

Bulletin No. 237, issued by the Jeffrey Manufacturing Co., of Columbus, Ohio, describes a chain-bucket elevator and conveyer, containing a number of new features in design and construction. As most commonly installed, the conveyer includes two vertical legs and two horizontal spans, tripping devices being used to dump the buckets at any desired point on the upper horizontal span. The principal points of improvement in the latest design refer to the construction of the links, rollers, and bushing. The design of the roller bearing with its bushing and its method of attachment to the bucket and links is shown in Fig. 1.

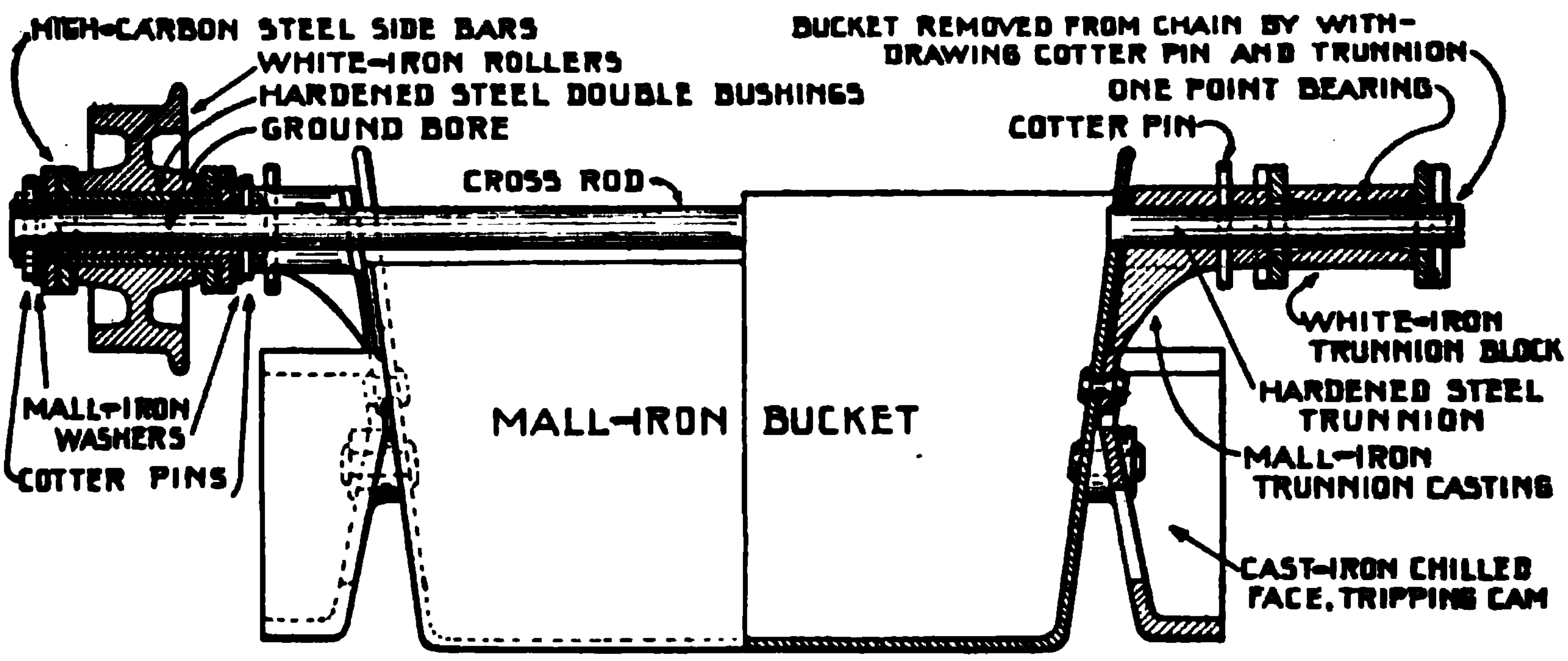


FIG. 1.

The two hardened steel bushings are assembled one within the other, the outer one fixed to the inside bars and the inner bushing fixed to the outside bars. The outer bushings serve as bearings for the chain rollers, while the inner bushings act as chain pins and receive the carrier cross rods. It is to these cross rods that the chains are readily assembled by means of malleable washers and large cotter pins on each side of the chain joints—the cotter pins passing through extensions of the inner bushings beyond the outside bars and down through the cross rods. Lugs in the steel side bars are locked tight to notches in both ends of the bushings.

[Continued on second following page.]

THE MINING AND METALLURGICAL INDEX

May and June, 1918

The Engineering Societies Library is prepared to supply the original, or a copy, translation, or abstract of any paper mentioned in the following index, at the following rates:

Translations, per 1000 words: German or French, $3.50; other languages, $4.50 and upward, by arrangement.
Copies of articles, maps, drawings, etc.
Photoprints, 10 by 14 in., per sheet $0.25
Typewritten, per 1000 words 1.00
Bibliographic searching, abstracting, etc., per hour $1.50
Original article, publisher's price, plus postage. Orders for periodicals will be forwarded to the publishers, and bill will be mailed from the Library.

Address communications relating to the Index to Engineering Societies Library, 29 West 39th Street, New York.

In the following Index, volume numbers are given in heavy-faced figures, page numbers in light-faced figures.

MINERAL RESOURCES

Adams, H. Nitrate lands in Chile. *Min. & Sci. Press* (May 18, 1918), **116**, 678.
Allen, M. A. War materials. *Arizona Min. Jour.* (June, 1918), **2**, 30.
American nitrate manufacture. *S. African Min. Jour. & Engineering Rev.* (Mar. 16, 1918), **27**, 669.
Bassin houiller des Alpes Francaises. (Coal basin of the French Alps.) *L'Echo des Mines et de la Métallurgie* (June 16, 1918), 291.
British australasian zinc. *Min. Jour.* (Apr. 27, 1918), **121**, 240.
British iron ore supplies. *Engineer* (London) (Apr. 12, 1918), **125**, 322.
Burrows, A. G. Matachewan Gold Area. *Canadian Min. Jour.* (June 15, 1918), 199–202.
California; new map of ore deposits of Inyo County. *Jour.* Am. Min. Congress (June, 1918), **4**, 233.
Cayeux, M. Les Minerais de Fer Americains. (Iron ore of America.) *L'Echo de Mines et de la Métallurgie* (June 2, 1918), 258–261.
Clausen, E. H. Aroroy gold mining district. *Min. & Sci. Press* (May 4, 1918), **116**, 615–618.
Coal Deposits of Brazil. *Coal Trade Jour.* (May 15, 1918), 640. Abstract of Report of Brazilian Minister of Agriculture, Industry and Commerce.
Coal of the Raton Mesa region. *Am. Gas Engineering Jour.* (July 6, 1918), **109**, 8.
Coal Riches in Southern Algeria. *Coal Age* (May 11, 1918), **13**, 876.
Davis, H. E. Molybdenum in San Diego. *Salt Lake Mining Rev.* (June 15, 1918), **20**, 28.
Dolbear, S. H. Possible Sources of Barium Carbonate. *Min. & Sci. Press* (May 4, 1918), **116**, 611.
Future of British Iron-ore Supply. *Iron & Coal Trades Rev.* (Mar. 1, 1918), 233. Editorial.
Graphite in South America. *Mining Mag.* (June, 1918), **18**, 320.
Great Northwest. *Salt Lake Mining Rev.* (May 15, 1918), **20**, 37. Discovery of chrome ore and other minerals.
Iron Ore Deposits of Brazil. *Iron Age* (May 2, 1918), **101**, 1143.
Iron Ore in Midlands. *Mining Mag.*, **18**, 167.
Iron Ore of China. *Engineer* (London), (Apr. 12, 1918), **125**, 315.
Jenkins, F. W. Little Namaqualand and its possibilities as a further copper producing country. *Trans.* North of England Inst. of Min. & Mech. Engineers (Oct., 1918), **68**, 7.

Thus all wear is confined to the bushings, which may be replaced after long service and a practically new chain obtained at very little cost.

The buckets are made of malleable iron for handling coal and ashes, and of gray steel for handling hot materials; edges and corners are reinforced for additional strength. The dimensions of three sizes carried are shown in the following table:

Buckets		Chains		Carrying Capacity for Coal, Tons per Hour at 50 Ft. per Min.
Width, In.	Length, In.	Pitch, In.	Dia. Rollers, In.	
16	18	18	5	30
18	24	24	6	50
24	24	24	6	70

The power requirements of the conveyer are given in a few instances. The Transue Williams Steel Forging Corporation, Alliance, Ohio, has an 18 by 24-in. carrier with a 48-ft. vertical lift, and 165-ft. horizontal span, which carries 50 tons of crushed coal per hour with an expenditure of 6 to 7 hp. The Solar Refining Company, of Lima, Ohio, has a 24 by 24-in. carrier with vertical lift of 66 ft. and horizontal run of 107 ft., handling 70 tons of crushed coal per hour with 8 to 10 hp.

ROTURBO CENTRIFUGAL PUMPS

Bulletins 53 and 54 of the Manistee Iron Works Co., Manistee, Mich. (50 Church St., New York), besides describing the Roturbo pumps in detail, discuss the fundamental reasons for their superiority when working under adverse and variable conditions as to lift, volume, speed, etc.

Hitherto centrifugal pumps have fallen short of the requirements of many problems due to their tendency to wear and consequent loss of efficiency when dealing with gritty water; also because of the lack of self-regulation or automatic adjustment to varying heads. Self-regulation, when attempted, should be secured with the highest average efficiency over a wide range of duty.

Until about 15 years ago it was generally agreed that centrifugal pumps were suitable only for low lifts and large volumes of water. No doubt the delayed development was largely due to the fact that, to get the best results from a centrifugal pump, impellers should be of small diameter running at high speed, rather than of large diameters running at low speed, but until the advent of the electric motor and steam turbine there was no means of driving centrifugal pumps at the necessary speed except through belting or gearing, with their inseparable difficulties and losses in transmission, which neutralized the advantages aimed at in the pumps.

Perhaps the defect which has been the most difficult to overcome has been the fact that it would work at its best only at the exact head for which it was designed, the reason of this being that the blades of the impeller were shaped so as to pass a certain amount of water with the minimum frictional loss, due to cavitation; but if the head is reduced, a greatly increased volume of water passes and the impeller then becomes unsuitable for the increased speed of the water through it and begins to act as a water brake, thus creating an overload on the driving machine. Consequently a large margin of power in the driver is usually specified to evade this defect.

It was attempted to overcome these conditions by designing the impeller with the blades bent rearward so as to reduce the brake effect. This necessitated increase in the speed of the impeller to compensate for the slip of the water, and beyond a certain amount of recurvature the capacity of the pump was greatly

 [Continued on second following page.]

JENKINS, O. P. Two Manganese Deposits in Northern Washington. *Eng. & Min. Jour.* (June 15, 1918). **105,** 1082.
McCALLIE, S. W. Mineral resources of Georgia. *Met. & Chem. Eng.* (May 1, 1918), **18,** 451.
Magnesite in Clinton mining division. *Min. & Eng. Rec.* (Mar. 31, 1918), **23,** 59–63.
Manganese at Butte, Mont. *Eng. & Min. Jour.* (June 15, 1918), **105,** 1076–79. Serial.
Manganese in Nevada. *Eng. & Min. Jour.* (June 29, 1918), **105,** 1186.
Manganese Possibilities in Eastern Cuba. *Min. & Sci. Press* (May 11, 1918), **116,** 656,
MATTHEWS, E. B. Mineral resources of Maryland. *Met. & Chem. Eng.* (May 1, 1918). **18,** 453.
Mineral Resources of the Appalachian South. *Met. & Chem. Eng.* (May 1, 1918), **18,** 449–451.
Mineral Resources of Canada. *Min. & Eng. Record* (Mar. 31, 1918), **23,** 48
Mineral Resources of the Empire. *S. Af. Eng.* (Mar., 1918), **29,** 42–44.. Serial.
O'BRIEN. Washoe-Plumas Copper Belt. *Salt Lake Mining Rev.* (May 15, 1918), **20,** 32.
O'BRIEN, J. F. Possibilities north of Reno. *Salt Lake Min. Rev.* (Apr. 30, 1918), **20,** 30. Copper Belt.
Platinum in British Columbia. *Canadian Min. Jour.* (June 15, 1918), **39,** 215.
PRATT, J. H. North Carolina Minerals. *Met. & Chem. Eng.* (May 1,1918). **18,** 453–55..
STIRLING, J. T. Alberta mines can supply all coal needed in Prairie Provinces *Canadian Min. Jour.* (Mar. 19, 1918), 157.
Tin in the Siamese Malaya. *Eng. & Min. Jour.* (May 18, 1918), **105,** 917.
TRILLO-FIGUEROA, A. C. Grafitos de la Provincia De Huebra. *Revista Minera, Metalurgica y de Ingenieria* (May 1, 1918), 215–217.
WALKER, E. Imperial Department of Mines. *Bulletin* Canadian Mining Institute (May, 1918), 399–402. Mineral resources.
WATSON, T. L. Mineral resources of Virginia in the chemical industries. *Met. & Chem. Eng.* (May 1, 1918). **18,** 456–458.
WHITE, I. C. Mineral resources of West Virginia available for chemical metallurgical and electro-metallurgical manufacturing. *Met. & Chem. Eng.* (May 1, 1918). **18,** 458.

MINING GEOLOGY AND MINING PRACTICE

Accidents in 1917 at Butte & Superior. *Eng. & Min. Jour.* (May 11, 1918). **105,** 881.
Air compressor in a gassy mine. *Coal Age* (May 11, 1918), **13,** 893.
Alloying minerals, stimulate output. *Iron Age* (May 2, 1918), **101,** 1154–1155.
American Institute of Mining Engineers, Its title. *Min. & Sci. Press* (May 25, 1918), **116,** 729.
Anthracite mines get more labor. *Jour.* Min. Congress (May, 1918), **4,** 197.
Alaska coal lands, application for lease of. *Alaska Railroad Rec.* (Apr. 23, 1918), **2,** 190.
Approved mine safety lamp development. *Coal Ind.* (May, 1918), **1,** 189.
Arizona copper production. *Arizona Min. Jour.* (June, 1918), **2,** 67.
ASHWORTH, J. Prevention of mine explosions. *Coal Age* (May 18, 1918), **13,** 915.
Asphalt. Mines italiennes d'asphalte. *Jour. du Petrole* (Apr., 1915), **18,** 9–10. Italian asphalt mines.
BAIN, H. F. Excess-profit and mine taxation. *Min. & Sci. Press* (May 18, 1918), **116,** 677. Letter.
BALL, L. C. Silver Spur mine—recent developments and future prospecting. *Queensland Govt. Min. Jour.* (Apr. 15, 1918), 152–160.
Barberton mines. *S. Af. Min. Jour. & Eng. Rec.* (Apr. 6, 1918), **27,** 736.
BOWEN. Taxation, rating, and valuation of mines. *Iron & Coal Trades Rev.* (Mar. 1, 1918), 221–223.
Brakepan mines, year with the. *S. Af. Min. Jour. & Eng. Rec.* (Apr. 6, 1918), **27,** 739.
BREWSTER, E. M. Drilling shot holes in Utah coal. *Salt Lake Min. Rec.* (May 15, 1918), **20,** 31.
Britain's pocketed coal mines. *Coal Age* (May 11, 1918), **13,** 885.
BROWN, G. L. Signals for rescue brigades. *Iron & Coal Trades Rev.* (Mar. 29, 1918), **96,** 341.
BROWN, H. L. AND HAYWARD, M. W. Molybdenum mining at Climax, Colorado. *Eng. & Min. Jour.* (May 18, 1918), **13,** 905–907.
BUTLER, B. S. Importance of large and small mines in the production of copper. *Steel and Metal Digest* (June, 1918). **8,** 358–360.

reduced and the internal friction of the impeller increased, with consequent loss of head at anything but a restricted range of service.

The problem of varying heads has been completely solved by the Rees Roturbo pressure-chamber impeller, which was introduced in Europe in 1907. The characteristic feature of this pump is that it is a true turbine pump, that is to say, the rotor has a strong turbine effect. This is secured by making the rotor of large capacity for storing water which is maintained by rotation at a constant maximum internal pressure with the minimum amount of loss; consequently, instead of throwing away the surplus kinetic energy of the water discharged when the head of delivery is reduced, this energy is utilized before the water leaves the pump casing.

In a pump so constructed, it is found that the power absorbed when running at a constant speed remains practically constant for all heads of discharge and heights of suction, and never appreciably exceeds that required for the total head for which the pump is designed. Thus, such a pump is self-regulating, it being impossible, by any variation of head or suction lift, to throw any excessive load on the driving motor. In the characteristic curve of the Roturbo pump, the power rises to a maximum at about normal head and volume, but the head can be reduced to any extent without affecting the power curve, and the discharge can be reduced below the atmospheric line, into vacuum, without any effect except reducing the power required for the motor.

The design of the Roturbo pump differs from the ordinary impeller or flat disc runner, which is formed with the main object of securing velocity of the water in the expanding channels of the fixed casing. With the Roturbo pressure-chamber, the water, after being picked up at the eye, becomes practically stationary, relative to the pressure-chamber itself, thus eliminating friction losses, and generating a pressure by centrifugal force. The inner portion of the impeller, between the eye and the largest section of the pressure-chamber, may be looked upon as a centrifugal pump proper and the blades of this portion are designed like those of an ordinary centrifugal pump. The rim portion, beyond the pressure-chamber, is designed as a reaction turbine, having rearwardly directed nozzles, discharging from the pressure-chamber.

The pump is, therefore, always discharging with a constant pressure, which is the ideal condition for a centrifugal pump, and the turbine is always discharging from a constant pressure, which is the ideal condition for a turbine. The result of a combination of a pump and turbine, with a pressure-chamber between them, is that the self-regulation is perfect, and at any heads lower than normal duty the power taken from the motor is prevented from rising. As the speed of the water in passing through the pressure-chamber is reduced to a minimum, a high efficiency is secured without the necessity of machining or polishing blades or surfaces. The internal wear is also minimized.

The Roturbo pumps are used for pumping sewage, mine drainage, boiler feeds, pressure augmentors, for city service, fire protection, dock pumping, cooling towers and condensing plants, etc. Due to the self-regulating characteristics of this pump the streams can be delivered through any number of pipes without overloading the engine when the head is reduced. Consequently, the maximum power of the engine can be utilized at all times, no matter what the head may be, since it runs at constant speed.

The Roturbo pumps are made of single- and multi-stage types, vertical and horizontal, and are usually designed to be direct-connected to a motor.

GOODCHILD, W. H. Evolution of ore deposits from igneous magmas. *Min. Mag.* (June, 1918), **18,** 186–194, 296–306.
GRAY, H. E. Nature of mine explosions. *Coal Age* (May 18, 1918), **13,** 930–931.
Greater use of domestic ores imperative. *Eng. & Min. Jour.* (May 4, 1918), **105,** 841.
Gypsum, arrangement of mills, and cost of manufacture. *Eng. & Cement World* (May 1, 1918), 86–92.
HAGGEN, E. A. Surf Inlet Mine. *Min. & Eng. Rec.* (1918), **23,** 5–21.
HALL, A. L. Mines of the Barberton District. II, *S. African Min. & Eng. Rec.* (Mar. 16, 1918), **27,** 661. Serial. III (Mar. 23, 1918), **27,** 686–687.
HANEY, M. Manganese ore in Virginia. *Iron Age* (June 27, 1918), 1659.
HANEY, M. Mining manganese at Crimora, Virginia. *Eng. & Min. Jour.* (May 11, 1918), **105,** 875.
HATCH, F. H. Jurassic ironstones of the United Kingdom, economically considered. Iron & Steel Inst. *Advanced copy* (1918), **4,** 1–46.
HEALY, R. L. Powder blast at the perseverance mine, Juneau, Alaska. *Eng. & Min. Jour.* (May 18, 1918), **105,** 922–923.
Herculean blasting. *Arizona Min. Jour.* (June, 1918), **2,** 32.
HESLOP, WM. T. Natal coal fields—Phases in development. *Jour.* Chem. Metall. & Min. Soc. of South Africa (Feb., 1918), **18,** 184–185.
HESSE, A. W. AND QUICKEL, K. M. Some experiences with a borehole. *Coal Age* (June 22, 1918), **13,** 1146–1147.
HICKS, F. B. Echoes from the mine and camp. *Coal Age* (May 25, 1918), **13,** 980–981. Letter.
HIRSCHBERG, C. A. Compressed air in the coal mine. *Compressed Air Mag.* (May 23, 1918), **23,** 8745–8751.
HOPWOOD, W. Some personal experiences in mechanical mining and peculiar geological features in a South Wales Colliery. *Iron & Coal Trades Rev.* (Mar. 29, 1918), **96,** 342–344.
HOSKIN, A. J. Mining in Colorado. *Min. & Sci. Press* (May 4, 1918), **116,** 625–626.
House debates mineral control bill. *Eng. & Min. Jour.* (May 4, 1918), **185, 844.**
HUTCHINS, J. P. Drift gravel mining in Eastern Siberia. *Eng. & Min. Jour.* (May 11, 1918), **105,** 859–866.
Illinois mine manager's examination, April 2, 1918. *Coal Age* (May 25, 1918), **13,** 985.
Improved rolling stock for mine service. *Coal Ind.* (May, 1918), **1,** 185–186.
Industrie de l' antimoine en France. *Echo des Mines et de la Métallurgie* (June 16, 1918), **46,** 297–298. Antimony industry in France.
Industrie estrattive e metallurgiche Attivita mineraria Italiana nel 1916, Ricerche Minerarie. *Industria-Revista Tecnica* (Apr. 15, 1918), **32,** 213–217. Extractive and metallurgical industries.
INNES, J. Estimation of injurious dust in mine air by the Kotze Konimeter. II. *S. African Min. Jour. & Eng. Rec.* (Mar. 23, 30, 1918), **27,** 701, 715. Serial.
JACOBSON, E. S. Use of powder in open-cut blasting. *Eng. & Min. Jour.* (June 22, 1918), **105,** 1130–1131. Letter.
JAMES, H. D. Industrial controllers. XVII—Mine hoists. *Electric Jour.* (May, 1918), 175–180.
JENNINGS, H. Gold industry, and gold standard. *Eng. & Min. Jour.* (May 1, 1918), **105,** 867–874; *Mining Congress Jour.* (May, 1918), **4,** 186–191; *Min. & Sci. Press* (May 11, 1918), **116,** 643–653; *Can. Min. Jour.* (May 15, 1918), **39,** 167–173.
JENSEN, H. I. Notes on the geology of Jibbenbar and the state arsenic mine. *Queensland Govt. Min. Jour.* (Mar. 15, 1918), **19,** 20–122.
Kathleen mine of the Union Colliery Company at Dowell, Illinois. *Coal Age* (June 29, 1918), **13,** 1186–1188.
KITSON, H. W. Mining districts of Joplin, and southwest Missouri. V, *Eng. & Min. Jour.* (June 29, 1918), **105,** 1153–1162. Serial.
KNOX, G. Use of concrete for mine supports. *Iron & Coal Trades Rev.* (Mar. 8, 29, 1918), **96,** 245–46.
Leasing system *vs.* State mining. *South African Min. Jour. & Eng. Rec.* (Apr. 13, 1918), 763.
LEE, F. C. Some practical notes on the economical use of timber in coal mines. *Trans.* North of England Inst. of Min. & Mech. Engrs. (June, 1918), **67,** 32–34.
LETTSOME, A. R. Developing an Illinois coal property. *Coal Ind.* (May, 1918), **1,** 163–164.
Life and care of hoisting ropes. *Coal Age* (July 6, 1918) **14,** 11–13.
LOUIS, H. Author's reply to discussion on the incidence of taxation upon metal-

liferous mining in the British Isles. *Bull.* Inst. Min. & Metall. (1918), **162,** 23–26.

Lumen. What caused the explosion? *Coal Age* (May 25, 1918), **13,** 183. Letter.

Maguire, D. Historical notes on the silver-bearing sandstones of Utah. *Salt Lake Min. Rec.* (May 15, 1918), **20,** 25–27.

Maize, R. Resistless air stoppings for coal mines. *Coal Ind.* (May, 1918), **1,** 162.

Manganese ores, valuation. *Eng. & Min. Jour.* (June 29, 1918), **105,** 1163–1165.

Manganese requirements. *Min. & Sci. Press* (May 25, 1918), **116,** 728.

Manning, V. H. Safety devices developed by the Bureau. *Coal Ind.* (June, 1918), **1,** 224–229.

Martin, P. F. Metals and metal industries of Latin America. *Metal Ind.* (May 24, 1918), **12,** 397–398.

Maxwell, W. H. Modern methods of shaft sinking. II, *Coll. Guard.* (Apr. 26, 1918), **115,** 833–844. Serial.

McTrusty, J. W. Status and training of colliery deputies. *Iron & Coal Trades Rev.* (Mar. 8, 1918), **96,** 258–259.

Measuring coal areas and making coal summary sheets. *Coal Age* (May 25, 1918), **13,** 954–955.

Miller, C. L. Chain power transmission. *Coal Ind.* (June, 1918), **1,** 232.

Milnes, P. R. Yava County mining. *Salt Lake Min. Rev.* (Apr. 30, 1918), **20,** 24.

Miltown, F. German wiles gain Normandy ore. *Iron Trade Rev.* (May 23, 1918), **62,** 1310–1311.

Mine manager's examination. *Coll. Guard.* (May 31, June 7, 1918), **115,** 1096, 1146. Serial.

Mine shaft sinking to coal strata. *Coal Ind.* (May, 1918), **1,** 172–173.

Mine statistics standardization. *Coal Age* (July 6, 1918), **14,** 27.

Mine taxation, union revenue from. *S. African Min. Jour. & Eng. Rec.* (Mar. 23, 1918), **27,** 682–683.

Mine timber selection. *Coal Age* (May 18, 1918), **13,** 941–942.

Mineral administration bill passes House. *Min. Congress Jour.* (May, 1918), **4,** 174–177.

Mineral and metal production to be accelerated in United States. *Oil, Paint, & Drug Reporter* (May 20, 1918), **93,** 65.

Mineral control bill considered by Senate committee. *Eng. & Min. Jour.* (May 11, 1918), **105,** 889.

Mineral control bill passes House. *Eng. & Min. Jour.* (May 4, 1918), **105,** 849.

Mineral imports to be curtailed even further. *Min. Congress Jour.* (May, 1918), **4,** 182.

Mineral land leasing bill. *Min. Congress Jour.* (May, 1918), **4,** 169.

Minerals control bill. *Bulletin* Min. & Metal. Soc. of Am. (1918), **11,** 116–117. *Metal. & Chem. Eng.* (May 1, 1918), **18,** 442–443. *Eng. & Min. Jour.* (May 25, 1918), **105,** 970–971.

Miners lamps, testing. *Eng.* (Apr. 26, 1918), **105,** 448–451.

Mines administration bill. *Eng. & Min. Jour.* (May 18, 1918), **105,** 933.

Mines et la métallurgie en Algerie et Tunisie. *Echo des Mines et de la Métallurgie* (June 9, 1918), **46,** 274–275. Mines and metallurgy in Algeria and Tunis.

Mines, safe and unsafe practices. *Eng. & Min. Jour* (May 4, 1918), **105,** 832–833.

Mining and education in Scotland. *Coll. Guard.* (Apr. 12, 1918), **115,** 743.

Mining education. *Indian Eng.* (Apr. 27, 1918), **63,** 225–227. Editorial.

Mining in Mexico is increasing. *Min. Am.* (Apr. 29, 1918), **77,** 8. Editorial.

Mining industry, progress and importance. *Sci. & Art of Min.* (June 15, 1918), **28,** 428.

Mining legislation. *S. African Min. Jour. & Eng. Rec.* (May 11, 1918), **27,** 27.

Mining taxation. *Min. & Eng. Rec.* (Mar. 31, 1918), **23,** 48. Editorial.

Mitchell, F. H. War minerals. *Min. & Sci. Press* (Apr. 27, 1918), **116,** 574. Letter.

Mitchell, W. G. Siberian mining industry. II, *Russia* (May, 1918), **3,** 25–30. Serial.

Model safety-first coal mine in Central Illinois. *Coal Age* (July 6, 1918), **14,** 4–10.

Modern American pit. *Iron & Coal Trades Rev.* (Apr. 12, 1918), **96,** 393.

Modern coal tipples expedite production. *Coal Ind.* (May, 1918), **1,** 174.

Molybdenite in Colorado. *Colorado School of Mines Mag.* (May, 1918), **8,** 76.

Molybdenum and the mines control bill. *Eng. & Min. Jour.* (May 25, 1918), **105,** 966.

Molybdenum buyers are out of the market for time. *Colo. School of Mines Mag.* (May, 1918), **8,** 75.

Molybdenum, tungsten, and bismuth. *Australia Ind. & Min. Standard* (Apr. 4, 18, 1918), **59,** 303–304, 368–369. Serial.

SHAFT WORK

"Longyear Crew" at the Ankerite Shaft, So. Porcupine, Ontario. Work performed for the Coniagas Mines Co., Ltd.

We have had years of experience in **Shaft Sinking and Mine Development** in various parts of the United States as well as in foreign countries.

Write for further information concerning your particular job.

Contract Diamond Drilling
Manufacture of Diamond Drills and Supplies
Shaft Sinking and Mine Development

E. J. LONGYEAR COMPANY

EXPLORING ENGINEERS

710 Security Bldg., MINNEAPOLIS, MINN.

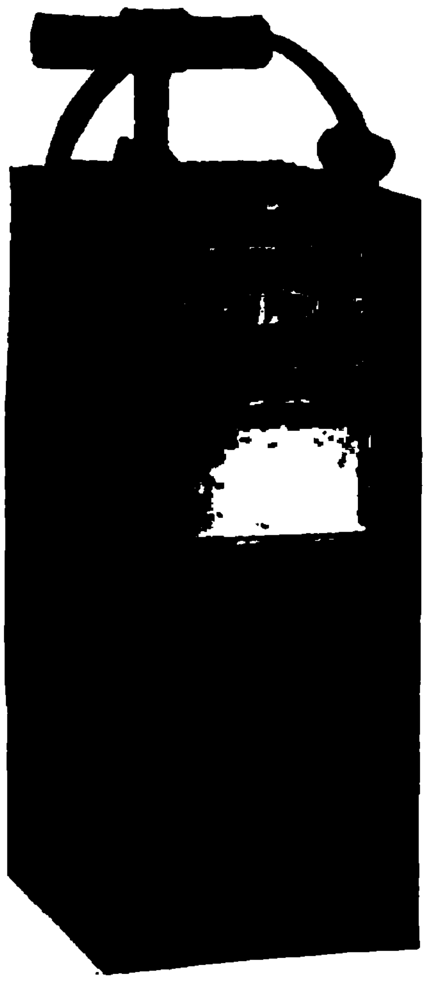
Don't Waste Explosives!

TAMP each charge thoroughly to confine the full force of the blast and use the explosive particularly designed for your kind of blasting operation. One means of conserving is to use Red Cross Explosives. Another economy is to

Fire Charges Electrically

There is no reason for using dynamite of over 40% or 60% strength when the same or better results can be accomplished with a grade of less strength.

And electric firing with dependable Du Pont blasting machines and electric blasting caps, is surer and safer.



Our High Explosives Booklet and our Blasting Supplies Catalog will advise what will best serve you. A postal request will bring you free copies.

E. I. du Pont de Nemours & Co.

Powder Makers Since 1802

Wilmington, Delaware

Queensland mining industry. Review of the year 1917–1918. *Queensland Gov't. Min. Jour.* (Mar. 15, 1918), **19**, 99–116.
Queensland State mining and boring. *Australian Ind. & Min. Standard* (Apr. 4, 1918), **59**, 304.
RASTALL, R. H. Genesis of tungsten ores. *Geological Mag.* (June, 1918), **5**, 241–246. Serial.
RAVENSHAW, H. W. Some useful instruments for colliery power plants. *Trans.* Inst. of Min. Engrs. (1918), **55**, 99–116; *Iron & Coal Trades Rev.* (Mar. 15, 1918), **96**, 284–285.
Recovery of coal in America. *Sci. & Art of Min.* (May 4, 1918), **28**, 378.
Recovery of French mines and coking plants. *Gas World* (May 5, 1918), **66**, 18.
Relative minerals control bill. *Arizona Min. Jour.* (May, 1918), **1**, 7–11.
Rhodesian mining and the war. *S. African Min. Jour. & Eng. Rec.* (Apr. 6, 1918), **27**, 737.
Rhodesian mining industry, review. *S. African Min. Jour. & Eng. Rec.* (Mar. 23, Apr. 13, 1918), **27**, 684, 773.
RICE, C. T. Fixing a chute mouth without emptying chute. *Eng. & Min. Jour.* (May 18, 1918), **105**, 923.
RICE, C. T. Recovering caved stopes in narrow veins. I. *Eng. & Min. Jour.* (June 15, July 6, 1918), **105**, 1069–1075; **106**, 1–7. Serial.
RICHARDS, A. F. W. Care and testing of colliery cables. *Iron & Coal Trades Rev.* (Mar. 22, 1918), **96**, 303–306.
RIES, H. Vanadium, ores, occurrence and uses. *Mineral Foote Notes* (May, 1918), **2**, 3–11.
ROBERTS, E. I. Exhaust-steam turbine installations at coal mines. *Coal Age* (June 15, 1918), **13**, 1101–1106. Serial.
Robinson Deep, year with the. *S. African Min. Jour. & Eng. Rec.* (May 4, 1918), **28**, 4.
RUPPRECHT. F. N. Gravity track system at anthracite coal breakers. *Eng. News-Rec.* (May 23, 1918), **80**, 1003–1005.
Salt domes, theory of volcanic origin. *Bull.* Am. Inst. Min. Engrs. (July, 1918), 1147.
SCOTT, J. Fluorspar. Its crystallizations and value. *Foundry Trade Jour.* (Apr., 1918), **20**, 211–212.
SEEWARD, F. Pit props and supports. British Pat. 114640. *Illus. Off. Jour.* (June 5, 1918), 931.
Shaft hoist equipment to increase output. *Coal Ind.* (May, 1918), **1**, 177–178.
Shaft sinking through quicksand. *Coal Age* (May 11, 1918), **13**, 891–892.
SHERMAN, G. Some lessons taught the mining industry of the Southwest. *Arizona Min. Jour.* (May, 1918), **1**, 3–6.
SHERMAN, P. M. Development of the Hazard coal field. *Coal Ind.* (June, 1918), **1**, 222–223.
Silver bill debate in the House of Representatives. *Min. & Sci. Press* (May 11, 1918), **116**, 659–660.
Small mechanical sampler. *Min. & Sci. Press* (June 15, 1918), **116**, 830.
SMITH. Coal mining in South Africa. *Mine & Quarry*, **10**, 1028–1031.
SMITH, W. A. Rock-drill. U. S. Patent No. 1267705. *Off. Gaz.* (May 28, 1918), 871.
SMITH, W. A. Rock-drill. U. S. Patent No. 1264217. *Off. Gaz.* (Apr. 30, 1918), 1015.
Some practical notes on the economical use of timber in coal mines. *Trans.* North of England Inst. Min. & Mech. Engrs. (Aug., Oct., 1918), **67**, 57–61; **68**, 1–5. Discussion.
South African mining statistics. *S. African Min. Jour. & Eng. Rec.* (Apr. 6, 1918), **27**, 735–736.
Spanish potash deposits legislation. *Am. Fertilizer* (June 22, 1918), **48**, 56–60.
SPENCER, A. C. AND HASTINGS, J. B. Geology and ore deposits of Ely, Nevada. *Min. & Sci. Press* (June 22, 1918), **116**, 857–862.
SPILMAN, C. F. Progress at Oatman. *Salt Lake Min. Rev.* (May 15, 1918), **20**, 39.
Spoiling the war minerals bill. *Min. & Sci. Press* (May 11, 1918), **116**, 638–639.
Spring mines, progress at. *S. African Jour. & Eng. Rec.* (Apr. 6, 1918), 738.
SPRINGER, J. F. Concrete in coal mine service. *Coal Age* (May 18, 1918), **13**, 916–919.
Springhill colliery explosion. *Iron & Coal Trades Rev.* (June 21, 1918), **96**, 699.
Steam turbine as applied to colliery work. *Iron & Coal Trades Rev.* (Mar. 1, 1918), **96**, 219–220.
STEBBINS, E. W. War excess-profit tax. *Min. & Sci. Press* (May 4, 1918), **116**, 607. Letter.

WENLOCK. Topics for underground officials. *Sci. & Art of Min.* (June 15, 1918), **28**, 422–424. Questions and answers.
WESTERVELT, W. Y. Minerals administration bill. *Min. & Sci. Press* (Apr. 27, 1918), **116**, 573–574. Letter.
WHITE, I. C. Coals of the Fairmont District. *Black Diamond* (June 22, 1918), **60**, 548–549.
WHITE, J. P. Miner's part in the World War. *Black Diamond* (May 25, 1918), **60**, 21.
WHITE, J. P. What the coal miner can do to help. *Railway Age* (May 31, 1918), **64**, 1343.
WHITTON, W. W. Formulas for mine valuation. *Min. & Sci. Press* (May 18, 1918), **116**, 691–694.
WILSON, E. B. Concrete as applied to coal mining. *Coal Ind.* (June, 1918), **1**, 201–202.
WILSON, E. B. Lackawanna Valley coal field of Pa. *Coal Ind.* (June, 1918), **1**, 17–19.
WILSON, E. B. Resistless air stoppings for coal mines. *Coal Ind.* (May, 1918), **1**, 161.
WILSON, H. M. AND FLEMING, J. R. Organizing safety work in mines. *S. African Min. Jour. & Eng. Rec.* (Mar. 9, 16, 23, Apr. 6, 13, 1918), **27**, 630, 659, 689, 745, 775. Serial.
WOAKES, E. R. Remarks on molybdenum in Norway. *Bull.* Inst. Min. & Metall., **162**, 21–22. Discussion.
WOLF, A. G. Sampling of mine floors. *Queensland Gov't Min. Jour.* (Apr. 15, 1918), **20**, 166–167.
WOLF, H. J. Molybdenum. *Colorado School of Mines Mag.* (May, 1918), **8**, 71–74.
Wolfram in depth. *Min. Mag.* (1918), **18**, 278–279.
WOOD, G. R. Report of committee on standardization of electrical equipment in coal mines. *Min. Congress Jour.* (May, 1918), **4**, 185.
WOOTON, P. Minerals control before Senate Mines committee. *Eng. & Min. Jour.* (May 18, 1918), **13**, 929.
Working ten-foot inclined seam. *Coal Age* (May 25, June 15, 1918), **13**, 982, 1126–1127.
Working upper and lower seams. *Sci. and Art of Min.* (Apr., 1918), **28**, 365–366.
Workmen's compensation act, some recent decisions. *Coll. Guard.* (Apr. 26, 1918), **115**, 849.
World's gold production. *Min. & Sci. Press* (May 4, 1918), **116**, 605–603.
Zinc from Broken Hill. *Min. & Sci. Press* (May 25, 1918), **116**, 727.

ORE-DRESSING AND PREPARATION OF COAL

ALDERSON, W. P. Mineral separator. U. S. Patent No. 1264135. *Offic. Gaz.* (Apr. 30, 1918), **281**, 991.
ALLEN, A. W. Milling in cyanide solution. *Metal. & Chem. Eng.* (May 15, 1918), **18**, 515–519. Gold and silver ores.
ATCHISON, E. J. Flotation of semi-oxidized silver ore. *Min. & Sci. Press* (Apr. 27, 1918), **116**, 575–577.
BAKER, M. H. Concentrating ores, British Patent No. 114594. *Illus. Offic. Jour.* (June 5, 1918), 912.
BLAND, G. V. Dry sizing as a means of preparing feed for concentration. *Eng. & Min. Jour.* (May 18, 1918), **105**, 908–911.
BRUNKER, W. A. Classifier, U. S. Patent No. 1265734. *Offic. Gaz.* (May 14, 1918), **250**, 265.
BURCH, H. K. Apparatus for classifying ores. U. S. Patent No. 1267373. *Offic. Gaz.* (May 28, 1918), **251**, 779.
Butte & Superior—Minerals separation decision by the U. S. Court of Appeals. *Eng. & Min. Jour.* (May 25, 1918), **105**, 926–965.
Butte & Superior—Minerals separation decision is modified. *Eng. & Min. Jour.* (May 25, 1918), **105**, 974.
CHANCE, T. M. New method of separating materials of different specific gravities. *Coal Age* (May 11, 1918), **13**, 866–869. (*Bull.* A. I. M. E. No. **134**, 265.)
Chance's method of coal separation. *Coal Age* (May 11, 1918), **13**, 876.
CHOMLEY, W. B. Description of the decantation plant in operation at the Great Fingall mine, Day Dawn. *Monthly Jour.* of the Chamber of Mines of Western Australia (Feb. 28, 1918), **17**, 15–19.

Coal Washing. A scientific study. *Trans.* Inst. Min. Engrs. (1918), 418–459.
Concentration of molybdenite ores in Ontario. *Eng. & Min. Jour.* (May 11, 1918), **105**, 880.
COOKE, R. C. H. Method for further reducing cyanide and zinc consumption. *Jour.* Chem. Metal., & Min. Soc. of South Africa (Feb., 1918), **18**, 185–186.
Crœsus Saver. *Salt Lake Min. Rev.* (Apr. 30, 1918), **20**, 25–26. Designed to make concentrating vanners extract a greater percentage of the ore values.
CROSS, W. L. New steel washery of the Locustdale Coal Co. *Coal Age* (May 25, 1918), **13**, 956–959.
Discussion of Mr. Thomas James Drakeley's paper on "Coal washing: a scientific study." *Trans.* Inst. of Min. Engrs. (1918), **55**, 158–166.
EDMONDS, H. R. Discussion on application of charcoal to the precipitation of gold from its solution in cyanide. *Bull.* Institution of Min. & Metallurgy (1918), **162**, 9–19.
EDQUIST, V. T. Converting an agitator into a continuous thickener. *Min. & Sci. Press* (May 11, 1918), **116**, 658.
Effect of addition agents in flotation. *Eng. & Min. Jour.* (May, 1918), **105**, 915–916.
FAHRENWALD, A. W. A new flotation machine. *Metal. & Chem. Eng.* (May 1, 1918), **18**, 487.
Flotation litigation. *Min. & Sci. Press* (June 22, 1918), **116**, 845.
Flotation royalties. *Min. & Sci. Press* (Apr. 27, 1918), **116**, 574.
HANDY, R. S. Hand-sorting of mill-feed. *Min. & Sci. Press* (June 22, 1918), **116**, 855–856.
Heap leaching of copper pyrites. *Eng. & Min. Jour.* (May 11, 1918), **105**, 882.
HENRY, E. C. Magnetic concentration of iron ores at Mineville, N. Y. *Eng. & Min. Jour.* (May 18, 1918), 912–914.
Historia da flutuação. *Revista Min. Met.* (Mar. 15, 1918), 17–20. History of flotation.
Last decision in the flotation case. *Eng. & Min. Jour.* (May 25, 1918), **105**, 976.
LINDAU, S. P. and EVANS, W. E. Improvised flotation dryer. *Min. & Sci. Press* (May 11, 1918), **116**, 657.
LLWELLYN, L. Coal washing apparatus. U. S. Patent No. 1267565. *Offic. Gaz.* (May 28, 1918), **251**, 831.
LOGAN, J. M. Ore washer and separator. U. S. Patent No. 1264667. *Offic. Gaz.* (Apr. 30, 1918), **251**, 1141.
LUNA, G. Formulas for ore sorting. *Eng. & Min. Jour.* (June 22, 1918), **105**, 1178.
MACDONALD, B. Automatic separation of solution from solids in the hydrometallurgical treatment of ore pulps. *Bull.* Amer. Inst. Min. Engrs. (July, 1918), 1141–1144.
Magnetic separators. *Canadian Foundryman* (June, 1918), **9**, 135.
MCCOMBRE. Cyaniding cere in situ. *Chem. Eng. & Min. Rev.* (Apr. 5, 1918), **10**, 208–209.
Meyer dry concentrator. *Salt Lake Min. Rev.* (Apr. 30, 1918), **20**, 31–32.
Middlings. *Eng. & Min. Jour.* (July 6, 1918), **106**, 13–14. (The term middlings is applied to a crushed product attached or imbedded in the gangue.)
Minerals separation, North American Corporation. *Eng. & Min. Jour.* (May 4, 1918), **105**, 843. Account of meeting.
Minerals Separation & Beer, Sondheimer & Co. *Min. & Sci. Press* (Apr. 27, 1918), **116**, 588.
Minerals Separation Butte & Superior. *Min. & Sci. Press* (May 25, 1918), **116**, 720–724.
Molybdenum content of ores and concentrates. *Eng. & Min. Jour.* (May 4, 1918), **105**, 836.
Nouveau mode de traitement des minerais. *Echo des Mines et de la Métallurgie* (June 16, 1918), 301.
Ore smelting in the Swansea district of Wales. *Queensland Gov't Min. Jour.* (Apr. 15, 1918), **20**, 164.
Precipitation of gold by carbon. *Min. Mag.* (1918), **18**, 170–171.
PRINGLE, L. B. Flotation of semi-oxidized silver ore. *Min. & Sci. Press* (May 18, 1918), **116**, 677–678.
RALSTON, O. C. Questions of ore flotation. *Min. Jour.* (London), (Apr. 6, 1918), **121**, 205–203.
RATCLIFFE, J. H. Treatment of tungsten ores. Letter. *Min. & Sci. Press* (May 25, 1918), **116**, 710.
Selective flotation in Australia. *Min. & Sci. Press* (May 4, 1918), **116**, 612.

COAL AND COKE

(See also Mineral Resources, Mining Geology and Mining Practice, and Ore-dressing and Preparation of Coal)

Coking coal in Scotland, occurrence of. *Colliery Guard.* (Apr. 12, 1918), **115**, 748.
Coking coals in Scotland. *Gas World* (Apr. 6, 1918), **68**, 19.
Coking practice, some future lines of advance. *Gas World* (May 5, 1918), **66**, 10–13.
COLEMAN, F. C. New regenerative coke oven plant at Thornaly ironworks. *Colliery Guardian* (Apr. 19, 1918), **115**, 794.
Conservation of coal. *Colliery Guard.* (Apr. 19, 1918), **115**, 793–794.
Cost of coal. *Coal Age* (June 29, 1918), **13**, 1190–1192.
Dangerous coal situation. Editorial on railroad situation. *Amer. Mach.* (May 2, 1918), **48**, 763.
Discussion on Mr. R. W. Dron's paper on "The occurrence of coking coal in Scotland." *Trans.* Inst. Min. Eng. (1918), **55**, 145–149.
Discussion of Mr. John Morison's paper on "A system of storing and filling small coal, with remarks upon the prevention of spontaneous heating in coal-heaps." *Trans.* Inst. Min. Engrs. (1918), **55**, 124–132.
ECKALL, H. J. How to move materials by machinery. *Industrial Management* (July, 1918), **56**, 42–49.
Electric service is speeding up coal mining operations. I, *Elec. Rec.* (July, 1918), **24**, 23–25. Serial.
Fairmont region of West Virginia. *Black Diamond* (June 22, 1918), **60**, 535–536.
Flow of air through small coal and other broken material. *Iron & Coal Trades Rev.* (June 21, 1918), **96**, 704.
FOXWELL, G. E. Chemists and the coking industry. *Gas World* (Apr. 6, 1918), **68**, 12.
Free use permits granted to mine coal on Little Susitna River. *Alaska R. R. Rec.* (Apr. 30, 1918), **2**, 195.
Further modification in zoning plans made. Official orders for West Virginia and Kentucky. *Coal Trade Jour.* (June 26, 1918), **50**, 814–816.
Garfield on the Fuel Administration. National Elec. Light Assoc. *Bull.* (Apr., 1918), **5**, 210–212.
German coal, iron, and steel industries. *Iron & Coal Trades Rev.* (Mar. 1, 1918), **96**, 225.
Germany's coal industry during the war. *Iron & Coal Trades Rev.* (Apr. 12, 1918), **96**, 391.
Government and the distribution of coal. *Sci. Amer.* (July 6, 1918), **86**, 6 *et seq.*
HACHITA, M. S. Utilizing anthracite culm. *Coll. Guardian* (Apr. 26, 1918), **115**, 855–856.
Illinois Fuel Administrator advises dealers to push sale of bituminous grades. *Coal Trade Jour.* (May 8, 1918), **50**, 612.
Importance of coke hardness. *Gas World* (June 1, 1918), **38**, 12.
Kia-Teseu-Yang. Coal deposits of China. *Coll. Guard.* (June 7, 1918), **115**, 1145.
LAURENT, M. T. Le service d'economie de combustible a la cie des forges et acieries de la Marine et D'Homecourt. *Rev. de Métallurgie* (Mar.-Apr., 1918), **15**, 117–126.
Modifies zone restrictions. Fuel Administrator extends limits of territories served by Iowa, Illinois, and the Virginias. *Coal Trade Jour.* (May 8, 1918), **50**, 618.
National electric power supply, report of coal conservation committee. *Tramway & Ry. World* (Jan. 17, 1918), **43**, 32–36.
New winter zone regulations on Illinois coals. *Coal Trade Jour.* (May 8, 1918), **50**, 618.
Opening of new coal mines limited under new regulations. *Min. Congress Jour.* (June, 1918), **4**, 216.
PARKER, E. W. Problem of coal supply. *Steam* (July, 1918), **22**, 13–17.
RAMSBURG, C. J., AND SPERR, F. W., JR. By-product coke and coking operations. *Coal Age* (May 11, 1918), **13**, 870–873.
Recovery of coal in America. *Sci. & Art of Mining* (May 4, 1918), **28**, 378.
Recovery of French mines and coking plants. *Gas World* (May 5, 1918), **66**, 18.
Reducing the risk in storing coal. *Proc.* Ill. Gas Assoc. (1918), 126.
Regulations concerning inspection of coal at mines, methods of preparation and definitions of grades. (1918.) United States Fuel Administrator, Wash. 8 pp.
Rulings of the United States Fuel Administration. *Black Diamond* (May 25, 1918), **60**, 445.
Rulings of the United States Fuel Administrator. *Black Diamond* (May 4, 11, 18, June 15, 22, 29, 1918), **60**, 380–382, 401–402, 421–422, 506–507, 526–528, 602–603.
Spontaneous combustion of coal. *Popular Mag.* (May, 1918), 23.
Spontaneous heating in coal heaps. *Coll. Guard.* (Apr. 19, 1918), **115**, 805.
Spontaneous firing of coal. *Trans.* North of Eng. Inst. Min. & Mech. Engrs. (Jan., 1918), **68**. 92–08.
STOEK, H. H. Benefits of coal storage at the mines. *Black Diamond* (May 4, 1918), **60**, 374–375.

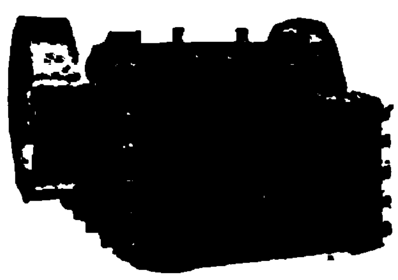
Storage of bituminous coal. *Railroad Herald* (June, 1918), **22**, 146–151.
Temporary storage an aid to production. *Black Diamond* (June 22, 1918), **60**, 555.
United States Fuel Administration directory. *Black Diamond* (June 29, 1918), **60**, 582–583.
WATKINSON, W. H. Our fuel resources and some possible improvements in their utilization. *Domestic Eng.* (June, 1918), **83**, 3–5.
Where production is easy at a low cost. *Black Diamond* (June 22, 1918), **60**, 543.
WILLIAMSON, H. A. Coal mine photography. *Coal Age* (June 15, 22, 1918), **13**, 1107–1108, 1148–1149. Serial.
WORKER, J. G. Combustion characteristics of coals. *Steam* (July, 1918), **22**, 10–13.
YOUNG, C. M. Heating of coal in piles. *Popular Engr.* (May 1, 1918), **9**, 11. (Reprint from A. I. M. E. *Bull.* No. 134.
ZIMMER, G. F. Recent methods to prevent spontaneous ignition of coal in silos. *Gas World* (Apr. 13, 1918), **68**, 266–268.
Zone system for the distribution of bituminous coal. *Amer. Mach.* (May 16, 1918), **48**, 842.

PETROLEUM AND GAS

BAKER, H. W. Present status of oil industry in Wyoming. *Salt Lake Min. Rev.* (Apr 30, 1918), **20**, 21–2.
Boulder oil fields, possibilities of greater production. *Min. Am.* (Apr. 29, 1918), **77**, 11.
BRADLEY, O. V. Losses of crude oil in steel and earthen storage. *Bull.* Amer. Inst. Min. Engrs. (July, 1918), **139**, 1135–1139.
British oil industry. *Indian Eng.* (Apr. 27, 1918), **63**, 228–229.
British petroleum and its economic value and national importance. *Petroleum Rev.* (Apr. 13, 1918), **38**, 230.
BURFORD, J. W. Application of electrical power to oilfield requirements. *Petroleum Rev.* (June 1, 1918), **38**, 347–348. Serial.
BURTON, G. E. Work of the petroleum geologist. *Eng. & Min. Jour.* (May 4, 1918), **105**, 822–24.
California fields, new developments. *Petroleum Rev.* (Apr. 13, 1918), **38**, 231.
Canadian oil and the Empire. *Petroleum World* (Apr., 1918), **15**, 141.
CLAPP, F. G. Geographic distribution of petroleum in South America. *Petroleum Rev.* (Apr. 13, 1918), **38**, 239–240. Serial.
COLLOM, B. E. Progress chart for comparison of a group of drilling wells. *Min. & Oil Bull.* (May, 1918), **4**, 227–228.
Colorado's petroleum opportunities attracting attention. *Mining Am.* (Apr. 29, 1918), **77**, 11.
Complete coördination of oil pipe lines and tankers effected for war time efficiency. *Min. & Oil. Bull.* (May, 1918), **4**, 231.
Compressed air increasing production of oil wells. *Compressed Air Mag.* (May, 1918), **23**, 8755–8759.
CORRAL, J. I. DEL. Examen industrial de los gases combustibles naturales. (Economic examination of natural combustible gases.) *Revista* de la Sociedad Cubana de Ingenieros (Apr., 1918), **10**, 181–212.
Cowdray would drill oil in Great Britain. *Eng. & Min. Jour.* (May 4, 1918), **105**, 824.
CRAIG, E. H. C. New British oil industry. *Iron & Coal Trades Rev.* (Mar. 1, 1918), **96**, 228–229.
CRAIG, E. H. C. Prospective oilfields of Barbados. *Jour.* Inst. Petroleum Technologists (1918), **4**, 68–78.
Development of oil shales to be great industry. *Salt Lake Min. Rev.* (June 15, 1918), **20**, 25–28.
Eastern fields reports further drops in wells finished and in production. *Oil, Paint & Drug Reporter* (Apr. 29, 1918), **93**, 53–55.
Expulsion of oil from a sand. *Petroleum World* (Apr., 1918), **15**, 167–170.
Federal oil division intelligently conducted. *Mining Am.* (Apr. 29, 1918), **77**, 8. Serial.
GARNER, J. B. Chemical possibilities of natural gas. *Chem. Engr.* (June, 1918), **26**, 245–254.
Gas wells frequently unprofitable from overdrilling. *Eng. & Min. Jour.* (May 4, 1918), **105**, 835.
GHAMBASHIDZE, D. Russian petroleum industry and its prospects. *Petroleum Rev.* (Apr. 13, 1918), **38**, 235–236.
HAZLETT, A. J. Developments in North Central Texas. *Oil Trade Jour.* (May, 1918), **9**, 76–80.
HOSKINS, A. J. Oil shale industry. *Western Eng.* (May, 1918), **9**, 191–198.

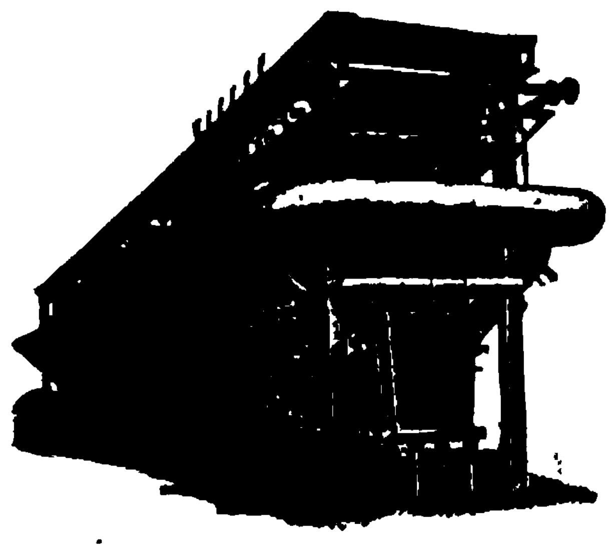
Hostile attitude of natives causes cessation of drilling in several districts in Mexico. *Oil Trade Jour.* (May, 1918), **9**, 12–16.
How casinghead gasoline is recovered. *Automotive Eng.* (May–June, 1918), **3**, 217–218.
How many gas wells to the square mile? *Min. & Oil Bull.* (May, 1918), **4**, 236.
HUME, W. F. Oilfields' region of Egypt. *Petroleum Rev.* (Apr. 20, 1918), **38**, 255–256. Serial.
Immediate relief promised petroleum field operators. Requa to urge priority manufacture and delivery of supplies. *Oil, Paint & Drug Reporter* (Apr. 29, 1918), **93**, 49.
Interpretation of the so called paraffin dirt of the Gulf Coast oil fields. *Bull.* Amer. Inst. Min. Engrs. (1918), **139**, 1148–1153.
ITO, K. Nippon Oil Company of Japan. *Min. & Oil Bull.* (June, 1918), **4**, 271–274.
LEWIS, J. O. Discussion on petrology of reservoir rocks. *Economic Geology* (Jan., 1918), **13**, 65–69. Letter.
LEWIS, J. O. Methods for increasing the recovery from oil sands. *Petroleum Rev.* (May 25), **38**, 333–334. (Apr. 13, 20, 27, May 25, 1918), **38**, 237–238, 253–254, 269–270. Serial. *Automotive Eng.* (May–June, 1918), **3**, 219–224.
LUCAS, A. F. Possible existence of deep-seated oil deposits on the Gulf Coast. *Bull.* Amer. Inst. Min. Engrs. (July, 1918), **139**, 1119–1134.
MANCHESTER, H. H. Use of natural gas in ancient times. *Gas Age* (July 1, 1918), **42**, 13–14.
Mascot has oil. *Salt Lake Min. Rev.* (May 15, 1918), **20**, 40.
MASTERSON, T. S. Petroleum industry of Rumania. *Jour.* Inst. Petroleum Tech. (1918), **4**, 79–103.
McLOUGHLIN, R. P. Value of engineering methods in oil fields. *Petroleum Rev.* (Apr. 20, 1918), **38**, 251–252.
Mexican Eagle's new well is rated at 50,000 bbls. *Oil Trade Jour.* (July, 1918), **9**, 72–74.
Mexican oil lands tax. *Oil & Gas Jour.* (June 28, 1918), **17**, 35–36.
MOORE, P. T. Phases of the war's effects on the petroleum industry. *Oil* (May, 1918), **9**, 3–4.
NEBEL, M. L. Cementation in the Illinois oil field. *Eng. & Min. Jour.* (June 15, 1918), **105**, 1080–1082.
Oil and coal developments in Portuguese West Africa. *Petroleum Rev.* (Apr. 13, 1918), **38**, 230.
Oil boring in Queensland. *Page's Eng. Weekly* (Apr. 26, 1918), **32**, 197. *Petroleum Rev.* (Apr. 27, 1918), **38**, 271.
Oil center of Western Canada shifts from Calgary—It is now at Edmonton. *Oil, Paint & Drug Reporter* (May 20, 1918), **93**, 600.
Oil deposits of Papua. Australian Commonwealth urges vigorous development. *Petroleum World* (Apr., 1918), **15**, 140.
Oil prospecting in the Gulf Coast Country, principles and problems. Discussion by W. Kennedy of paper by W. G. Matteson. *Bull.* Am. Inst. Min. Engrs. (1918), **139**, 1145–1146.
Oil shale industry. *Min. Amer.* (Apr. 29, 1918), **77**, 12–13.
Oil shales of the West. *Salt Lake Min. Rev.* (Apr. 30, 1918), **20**, 23–24.
Outlook for the oil industry. *Min. & Oil Bull.* (1918), **4**, 217.
PETERSON, F. P. Application of vacuum to oil wells. *Oil & Gas Jour.* (June 14, 1918), **17**, 45–46.
Petrole au Bresil. *Jour. du Petrole* (Feb.–Mar., 1918), 6.
Petroleum pendulum swings toward higher production. *Oil, Paint & Drug Reporter* (May 20, 1918), **93**, 49.
Petroleum situation and our national needs. *Min. & Oil Bull.* (May, 1918), **4**, 219–220.
Portuguese West Africa, Oil and Coal Developments. *Petroleum Rev.* (Apr. 13, 1918), **38**, 230.
Progress of world's deepest well. *Min. Amer.* (Apr. 1, 1918), **77**, 13.
Resources de la France en petrole et gaz naturels. *Jour. du Petrole* (Jan., 1918), 8–11.
REQUA, M. L. War service of the petroleum industry. National Gas Engine Assoc. *Bull.* (May, 1918), **3**, 14–16.
Romance of petroleum. *Eng.* (London) (June 14, 1918), **105**, 670–671.
Russian petroleum industry. *Eng.* (London) (Apr. 12, 1918), 402–403.
Russian petroleum prospects. *Gas & Oil Power* (Apr. 4, 1918), **8**, 106–107.
SANTAELLA. Nationalization of petroleum in Mexico. *Petroleum World* (Apr., 1918), **15**, 163–164.
SIMMONS, J. Two methods of drilling for oil. *Pahasapa Quarterly* (Apr., 1918), **7**, 29–32.

TRAYLOR EQUIPMENT
FOR
MINE, MILL AND SMELTER

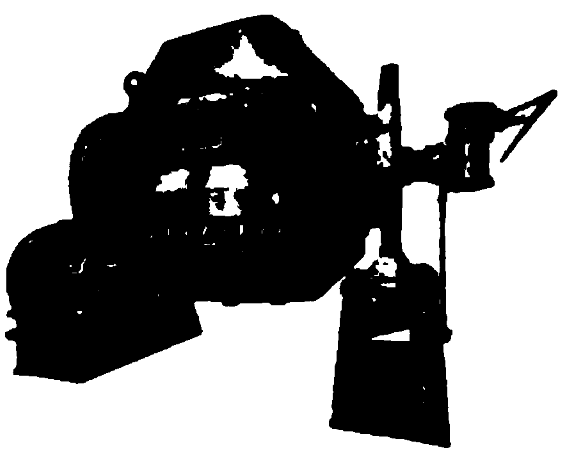


JAW CRUSHERS for every purpose all fitted with cast steel water-cooled pitman, water-cooled main pitman shaft bearings and built in sizes from 7" x 10" Jaw opening, up to and including the Giant 66" x 86" crusher weighing 680,000 pounds, the largest Crusher in the world. Bulletin J-1.

CRUSHING ROLLS with the "Fleeting Roll" the only Crushing Rolls built which have an automatic device for shifting the position of the fixed roll in a lateral direction. Corrugating and Flanging of the Roll shells eliminated, thus assuring a greater tonnage per set of shells, also a greater tonnage of finished product per horse power consumed. Built in sizes from 18" x 10" to 72" x 30" inclusive. Bulletin R-1.



SMELTING FURNACES for Copper or Lead Smelting equipped with Traylor Patented Water Jackets, having the tuyère an integral part of the fire sheet which is free from all projections, also, Traylor quick detachable tuyère connection and many other features which have made Traylor Smelting Furnaces World Standard, as evidenced by over 90% of all new smelting equipment purchased during the past fiscal year being made by us. Bulletin SF-1.



COPPER CONVERTERS so designed that any tuyère can be removed without interfering with the others. Tuyère Boxes that can be detached without disturbing the tuyère pipes because of the Williams connections. Shelby improved Tuyère valve, universal air connection, all features that make for efficiency and ease in operation. Bulletin C-1.

Traylor Engineering & Mfg. Co.

Main Office and Works: **Allentown, Pa., U. S. A.**

NEW YORK CHICAGO LOS ANGELES SPOKANE

Situation becoming serious for oil interests operating in Mexico. *Oil Trade Jour.* (May, 1918), **9**, 6–10.
Status of negotiations as to Carranza decree, United States government and producers stand firm. *Oil Trade Jour.* (July, 1918), **9**, 76–78.
United States oil trade with the Allies. *Petroleum Rev.* (Apr. 13, 1918), **38**, 233–234.
Unrecovered oil in abandoned wells. *Min. Amer.* (Apr. 1, 1918), **77**, 8–9. Editorial.
WADLEIGH, F. A. Treatment of oil shale in Colorado. *Eng. & Min. Jour.* (May 18, 1918), **105**, 917.
Wanted: A new fuel oil. Government's offer of an award. *Petroleum Rev.* (London) (Apr. 13, 1918), **38**, 229.
Warning and an establishment of policy by Oil Administrator Requa. *Oil, Paint & Drug Reporter* (May 27, 1918), **93**, 49.
WHITAKER, W. A. Petroleum industry in Kansas. *Eng. & Min. Jour.* (May 4, 1918), **105**, 817–821.
WOLF, J. H. G. Commercial aspects of the shale oil industry. *Min. & Sci. Press* (May 4, 1918), **116**, 613–14.

METALLURGY OF IRON AND STEEL

Acier electrique acide et basique. *Jour. du Four Electrique* (June 1, 1918), **11**, 133–134.
ALLEMAN, G. AND DARLINGTON, C. J. Occluded gases in ferrous alloys. *Jour.* Franklin Institute (Apr., 1918), **176**, 461–480. Serial.
Alloy Steel castings *vs.* forgings. *Iron Age* (May 30, 1918), **101**, 1427–1428.
ANDREWS, E. S. Permissible stresses in steel. *Eng. Rev.* (Jan. 15, 1918), **31**, 199–201. Serial.
ARCHER, A. E. Casting, etc., metals, British Patent No. 114928. *Illus. Off. Jour.* (June 12, 1918), 1039.
ARNOLD, H. C. Refractory materials used in casting plants. II, *Foundry* (July, 1918), **46**, 326–329. Serial.
BAILY, T. F. Electric furnaces for heat treatment. *Iron Age* (May 9, 1918), **101**, 1199–1201.
BARRETT, G. AND ROGERSON, T. B. Present knowledge and practice in briquetting iron ores. *Automotive Eng. Magazine* (June, 1918), **3**, 225–229. Serial.
BELAIEW, N. Damascene steel. Iron and Steel Institute, *Advance copy* (1918), **20**, 1–22.
Blast Furnace practice. *Engineering* (London) (May 3, 1918), **105**, 480–483. Report of Iron & Steel Inst. committee No. 2.
Blast Furnace practice. *Iron Age* (July 11, 1918), **102**, 86–87.
BOOTH, W. K. Booth-Hall electric furnace. Am. Electro-chemical Soc. *Advance copy* (1918), **11**, 95–105.
British Columbia & the Iron & Steel industry *Iron & Steel of Canada* (May, 1918), **1**, 153.
BROWN, G. M. Rolling mills and their electrical equipment. *Iron & Coal Trades Review* (Mar. 1, 1918), **96**, 224–225.
Burning of Steel. What it means. The different ways in which it may occur. *Iron Age* (May 16, 1918), **101**, 1269.
CAMPBELL, D. F. Electric furnace developments. *Iron & Coal Trades Rev.* (Mar. 15, 1918), **96**, 281.
Carbon monoxide poisoning in steel plants. *Iron & Coal Trades Rev.* (Mar. 8, 1918), **96**, 260.
CARPENTER, H. C. H. Iron-carbon equilibrium diagram and its practical usefulness. *Eng.* (London) (Apr. 12, 19, 25, 1918), **105**, 392–395, 426–427, 452–455. Serial.
Cast iron. U. S. Patent No. 1247252. *Practical Eng.* (June 6, 1918), **57**, 273.
CHARPY, G. AND BONNEROT, S. Sur l'hétérogénéité des aciers. *Revue de Métallurgie* (Mar., Apr., 1918), 132–136.
COLE, P. G. Use of producer gas in metallurgical industries. *Iron & Steel of Canada* (May, 1918), **1**, 181–188.
COLL, JAIME. El problema siderurgico. IV, *Madrid Cientifico* (May 25, 1918), **25**, 265–267. Serial.
Considerations sur les aciers. *L'echo des Mines et de la Metallurgie* (June 9, 1918), 280–283.
Converter steel castings. *Iron Age* (July 11, 1918), **102**, 88.
Cooling rate affects steel casting design. I, *Foundry* (May, 1918), **46**, 201–204.

CROSBY, F. B. Keystone Steel and Wire Co. A steel plant of the middle west. *General Electric Rev.* (May, 1918), **21**, 332–343.
DONALD, W. Magnesites and Magnesite bricks. *Iron & Coal Trades Review* (Mar. 15, 1918), **96**, 282.
Drive for eight-hour day at steel works. *Iron Age* (May 16, 1918), **101**, 1290–1291.
DUPUY, E. L. AND LECHATELIER, H. Sur l'hétérogénéité des aciers. *Revue de Métallurgie* (Mar.–Apr., 1918), 127–131.
Economy in blast furnaces. *Practical Eng.* (June 6, 1918), **57**, 272. Serial. Discussion.
El papel del vanadio en los aceros especiales. (Roll of vanadium in special steels.) *Revista Minera Metallurgica y de Ingenieria* (Apr. 24, 1918), 199–201.
Electric carbon tool steel. *Iron Age* (May 9, 1918), **101**, 1222.
Electric furnace for forging steel. *Iron Age* (June 27, 1918), **101**, 1676–1677.
Electric furnace for steel castings. *Iron Age* (May 16, 1918), **101**, 1282–1283.
Electric furnace reduces titaniferous ores. *Iron & Steel of Canada* (May, 1918), **1**, 199.
Electric Reduction of Iron Ore. *Times Eng. Sup.* (Jan. 25, 1918), 36.
Electric steel refining. *Iron Age* (July 11, 1918), **102**, 89.
Electro metallurgy, Director Manning shows importance of. *Metal & Chem. Eng.* (May 1, 1918), **18**, 441.
Electrolytic Pickling. *Iron Age* (May 9, 1918), **101**, 1202.
ELLIOTT, C. H. AND MCCLEARY, E. T. Open-hearth steel process, U. S. Patent No. 1266928. *Off. Gaz.* (May 21, 1918), **251**, 628.
ESPLOTACION i fabricacion del hierro i acero—(1). *Boletin* de la Sociedad Nacional de Mineria (Nov. and Dec., 1918), **30**, 564–570.
Essential foundry output not yet defined. *Foundry* (July, 1918), **46**, 291–292.
FARR, A. V. Electric steel and the forging industry. *Iron Age* (July 11, 1918), **102**, 74–76.
FLINTERMAN, R. F. Electric steel castings. Amer. Electro-chemical Soc., *Advance copy* (1918), **17**, 121–129.
FLINTERMAN, R. F. Electric steel for small castings. *Iron Age* (May 30, 1918), **101**, 1398–1400.
FOLEY, C. B. Electric furnaces, British Patent No. 114853. *Illus. Off. Gaz.* (June 12, 1918), 1008.
FOLKENING, F. C. Manufacture of tin plate for roofing. *Metal Worker, Plumber & Steam Fitter* (May 3, 1918), **89**, 577–580.
Foundry moulding machines. *Times Eng. Sup.* (June, 1918), 123.
FOXWELL, G. E. Some physical properties of acid refractory materials and methods for estimating them. *Iron and Coal Trades Rev.* (Apr. 12, 1918), **96**, 398–399.
French steel industry in war time. *Iron Age* (June 20, 1918), **101**, 1628–1629.
Fuel economy in blast furnaces. *Practical Engr.* (May 30, 1918), **57**, 259. Serial.
Gas burners for metallurgical furnaces. *Gas. Jour.* (Apr. 23, 1918), **142**, 148.
German coal, iron and steel industries. *Iron & Coal Trades Rev.* (Mar. 1, 1918), **96**, 225.
GILLETT, H. W. AND MACK, E. L. Preparation of ferro-uranium. *Min. Jour.* (Jan. 2, 1918), **120**, 31–32. Serial.
Government regulation in steel. *Iron Age* (May 23, 1918), **101**, 1352.
Government steel requisitions are on safe side. *Eng. News Rec.* (June 27, 1918), **80**, 1217–1219.
Great demand for fluorspar as flux. *Min. Amer.* (Apr. 29, 1918), **77**, 10.
GRIFFITHS, F. J. Rôle of chrome vanadium; its position among alloy steels. *Canadian Foundryman* (May, 1918), **9**, 106–108.
Hamilton and the iron and steel industry. *Iron and Steel of Canada* (May, 1918), **1**, 192–193.
HEATH, R. F. Improved test for tungsten. *Eng. and Min. Jour.* (July 6, 1918), **106**, 27.
HERBERT, A. Moulds for casting iron, British Patent No. 114701. *Illus. Off. Jour.* (June 5, 1918), 956.
HERING, C. Electrolytic pickling of greasy surfaces. *Metal. & Chem. Eng.* (May 1, 1918), **18**, 438.
HOLDEN, JOHN A. Dish-cast ingots. *Iron & Coal Trades Rev.* (Mar. 8, 1918), **96**, 254.
HOLDEN, J. A. Electric carbon tool steel. *Foundry Trade Jour.* (Apr., 1918), **20**, 193–194.

HORNER, J. Forging in dies under the steam hammer—I. *Mechanical World* (May 31, 1918), **63**, 259–260. Serial.
HOWE, H. M. Le grossissement du grain de l'acier. *Revue de Métallurgie* (Mar.–Apr., 1918), 137–172.
Huge chain cable is now cast successfully. *Foundry* (July, 1918), **46**, 310–313.
HUMMEL, E. C. Liquid ferro-manganese in open hearth. *Blast-furnace & Steel Plant* (May, 1918), **6**, 201.
HURTS, J. E. Growth of gray cast iron by repeated heating. *Foundry* (May, 1918), **46**, 227–229.
HUTCHINSON, T. C. Fuel economy in blast furnaces. Iron and Steel Inst., *Advance copy*, 1–15. *Iron & Coal Trades Rev.* (May 3, 1918), **96**, 490–491.
IBSEN, A. Braendselsokonomien i Kupolovne (Combustion in the cupola oven). *Ingenioren* (Apr. 13, 1918), 217–221.
Inclusions in steel and ferrite lines. *Iron & Coal Trades Rev.* (May 3, 1918), **96**, 486.
Indian Iron & Steel Co., Ltd. *Indian Eng.* (Mar. 16, 1918), **63**, 141–142.
Industries electrochimiques et electrométallurgiques en Italie. *Jour. du Four Electrique* (June 1, 1918), 129–130.
Inquiry on blast furnace practice in the United Kingdom. Iron & Steel Inst., *Advance copy*, 1–19.
Iron and steel in the south. *Metallurgical & Chemical Eng.* (May 1, 1918), **18**, 436.
Iron and steel making, historical side. *Iron & Coal Trades Rev.* (Mar. 15, 1918), **96**, 287.
Iron and steel trade. *Iron & Coal Trades Rev.* (Mar. 1, 1918), **96**, 235.
Iron and steel trade after the war. *Iron & Coal Trades Rev.* (June 21, 1918), **96**, 667–669.
Iron, topical talks on. *Steel & Metal Digest* (May, 1918), **8**, 289–290.
KEBLER, E. A. Summary of iron and steel processes. *Blast Furnace & Steel Plant* (July, 1918), **6**, 296–297.
KEEP, W. J. Anthracite coal for melting iron in a cupola. *Foundry* (July, 1918), **46**, 325.
KEIR, M. Economic factors in the iron industry. *Iron Age* (May 9, 16, 1918), **101**, 1078, 1204, 1342. Serial.
KELLER, J. D. Selecting steel by the spark method. *Mechanical World* (June 7, 1918), **63**, 272–273.
KILBY, J. N. Defects in steel ingots. Iron & Steel Inst., *Advance copy* (1918), 1–24. *Iron & Coal Trades Rev.* (May 3, 1918), **96**, 493–496.
KREUTZBERG, E. C. Win-the-war methods at the Essington Foundry. *Foundry* (July, 1918), **46**, 293–301.
La viscosité du laitier de haut-fourneau et la sidérurgie. *Métallurgie* (June 5, 1918), 837–839.
LANG, H. Classification of furnace slags. *Min. & Sci. Press* (May 4, 1918), **116**, 619–621.
LE CHATELIER, M. H. Metallographie microscopique (Microscopic metallography). *Revue Scientifique, Industrielle & Commerciale—Métaux et Alliages* (Mar., 1918), 5–8.
LOW, E. F. Effect of mass on heat treatment. Iron & Steel Inst., *Advance copy* (1918), 1–15.
LINDQUIST, D. L. Blast-furnace hoist installations. *Iron Trade Rev.* (June 20, 1918), 1543–1549.
LOUNSBERRY, F. B. Manufacture, inspection, etc. of crucible steel. *Jour.* of Cleveland Eng. Soc. (1918), **10**, 309–314.
Low-manganese, high-phosphorous spiegeleisen from slags. *Iron Age* (May 30, 1918), **101**, 1392.
MACFARLAND, A. F. Chemists' part in speeding up steel output. *Iron Age* (June 27, 1918), **101**, 1645–1648.
Magnesites and magnesite bricks. Eng. (London) (Apr. 26, 1918), **105**, 455.
Making cast iron in an electric furnace, British Patent No. 114328. *Practical Eng.* (June 13, 1918), **57**, 286.
Malleable iron vs. wrought iron castings. *Practical Eng.* (June 13, 1918), **57**, 280.
MAMMEN, M. A. Analysis of ferro-silicon. *Metal. & Chem. Eng.* (May 1, 1918), **18**, 438. Letter.
Manganese output steadily increasing. *Min. Amer.* (Apr. 1, 1918), 8. Editorial.
MATIGNON, C. Les Ferrosiliciums inattaquables aux acides. *Jour. du Four Electrique* (June 1, 1918), **27**, 137.
MCCANCE, A. Non-metallic inclusions; their constitution and occurrence in steel. Iron & Steel Inst., *Adv. copy* (1918), 1–48. *Iron & Coal Trades Rev.* (May 3, 1918), **96**, 499–500.

SHERMAN, C. W. Method of making cast-metal car wheels. U. S. Patent No. 1264338. *Off. Gaz.* (Apr. 30, 1918), **251,** 1048.
Sixty years of iron and steel. *Steel & Metal Digest* (May, 1918), **8,** 280–281.
SKINNINGROVE, T. C. H. Fuel economy in blast furnaces. *Eng.* (London) (May 3, 1918), **105,** 483–484.
SLICK, E. E. Blast-furnace operation. U. S. Patent No. 1267005. *Off. Gaz.* (May 21, 1918), **251,** 650.
SLICK, E. E. Blast furnace. U. S. Patent No. 1267004. *Off. Gaz.* (May 21, 1918), **251,** 650.
SNYDER, H. C. Telautographs expedite steel production. *Blast Furnace & Steel Plant* (May, 1918), **6,** 211–213.
Specifications for aircraft steels. *Iron Age* (July 11, 1918), **102,** 70–71.
STANSFIELD, A. Recent advances in Canadian metallurgy. *Canadian Foundryman* (May, 1912), **9,** 109–111.
STEAD, J. E. Blast-furnace bears. Iron & Steel Inst., *Adv. copy* (1918), **9,** 1–42. *Iron & Coal Trades Rev.* (May 3, 1918), **96,** 486–490.
STEAD, J. E. Iron, carbon, and phosphorous. Iron & Steel Inst., *Adv. copy* (1918), 1–24. *Iron & Coal Trades Rev.* (May 3, 1918), **96,** 485.
STEAD, J. E. Note on inclusions in steel and ferrite lines. Iron & Steel Inst., *Adv. copy* (1918), **13,** 1–6.
Steel making and the use of electric furnaces. *Iron & Coal Trades Rev.* (Mar. 22, 1918), **96,** 312.
Steel plants. *Steel & Metal Digest* (May–June, 1918), **8,** 299, 351.
Steel standards, concessions made in. *Iron Trade Rev.* (July 4, 1918), **63,** 33.
Steels for gears and their treatment. *Iron Age* (June 27, 1918), **101,** 1668–1670.
Stobie 15-ton electric furnace. *Iron & Coal Trades Rev.* (Apr. 12, 1918), **96,** 402–403.
Structure of metals. Examination by X-rays. *Times Eng. Supp.* (June, 1918), 125.
Swedish iron, steel, and coal industry in 1916. *Iron & Coal Trades Rev.* (Mar. 15, 1918), **96,** 287.
THOMPSON, M. Electrolytic pickling of steel. *Metall. & Chem. Eng.* (May 1, 1918), **18,** 437–438.
TURNER, T. Malleable cast iron. *Jour.* West of Scotland Iron & Steel Inst. (Mar., 1918), **25,** 285–310.
TURNER, H. W. Iron & steel technology. *Min. & Sci. Press* (May 4, 1918), **116,** 607.
Turns ore to wrought iron. *Iron Trade Rev.* (May 16, 1918), **63,** 1245.
UNGER, J. S. Phosphorus in soft open-hearth steel, Pt. II, *Blast Furnace & Steel Plant* (July, 1918), **6,** 302–306.
U. S. Tariff Commission holds hearings on tungsten at Denver. *Chem. & Metall. Eng.* (July 1, 1918), **19,** 11.
U. S. Tariff Commission and the metal industries. *Eng. & Min. Jour.* (May 4, 1918), **105,** 828.
Utilization of open-hearth basic slag. *Jour.* of the Soc. of Chem. Industry (May 31, 1918), **37,** 189–190.
VANDEN BROEK, J. A. Effects of cold working on elastic properties of steel. *Iron & Coal Trades Rev.* (May 3, 1918), **96,** 491–493. Iron & Steel Inst., *Adv. copy* (1918), 1–41.
VOM BAUR, J. H. Vom Baur arc furnace. Amer. Electro-Chem. Soc., *Adv. copy* (1918), **12,** 137–143.
WALTER, C. M. Pyrometry and its application to the metal trades. *Metal Industry* (Apr. 12, 1918), **12,** 286–290. Serial.
War materials, conditions in contracting for. *Iron Age* (June 27, 1918), **101,** 1656–1657.
WELLS, A. E. Governments metallurgical research work. *Mining Amer.* (Apr. 29, 1918), **77,** 3–4.
WHITELEY, J. H. Effect of cold work on the divorce of pearlite. Iron & Steel Inst., *Adv. copy* (1918), 1–9.
WINTERS, ABE. Corrosion of iron and steel and its prevention. *Canadian Machinery* (June 13, 1918), **19,** 625–626.
WRIGHTSON, T. G. AND KINGQUIST, J. M. Blast-furnace and the like, U. S. Patent No. 1267732. *Off. Gaz.* (May 28, 1918), 878.
YASUI KATSU. Chemical and metallurgical notes from Japan. *Chem. & Metall. Eng.* (July 1, 1918), **19,** 41.
Zirconia—Its possibilities in metallurgy. *Iron & Coal Trades Rev.* (Mar. 22, 1918), **96,** 311–312.
Zirconia as a refractory. *Iron Age* (July 1, 1918), **102,** 72–73.
Zirconia in steel metallurgy. *Iron Age* (May 16, 1918), **101,** 1276–1277.

Buyers, Smelters and Refiners

METALLURGY OF NON-FERROUS METALS

Aluminium. *Mining Jour.* (London) (Apr. 23, 1918), **121**, 217–218.

ANDERSON, R. T. Annealing and recrystallization of cold-rolled aluminium sheet. *Metal. & Chem. Eng.* (May 15, 1918), **18**, 523–527.

ANDERSON, R. T. On the annealing of aluminum. *Eng.* (London) (Apr. 12, 1918), **105**, 412–413.

Antisell's lugless copper anode. Details of milling and smelting. *Eng. & Min. Jour.* (May 18, 1918), **105**, 924–925.

l'Avenir de l'aluminum. *Jour. du Four Electrique et de l'Electrolyse* (May 1, 1918), **27**, 97–98.

Bibliography of the physical properties of copper. *Metal Rec. & Electroplater* (June, 1918), **4**, 169–173.

BISHOP, W. B. Matte-settlement and slag disposal at Grand Forks. *Min. & Sci. Press* (June 15, 1918), **116**, 819–823.

Brass melting, electric. *Metal. & Chem. Eng.* (May 1, 1918), **18**, 434–435.

Canada Copper Corporation United. *Min. & Eng. Rec.* (Mar. 31, 1918) **23**, 51–59.

CARPENTER, H. C. H. Cause and remedy for unsound castings in Admiralty bronze. Serial. *Metal Rec. & Electroplater* (Apr.–May, 1918), **4**, 111–113, 152–155.

CARPENTER, H. C. H. AND ELAM, C. F. Unsound castings of Admiralty bronze (88 : 10 : 2). Its cause and the remedy. *Practical Eng.* (Apr. 25, 1918) **37**, 198–200.

CHOATE, P. C. Research preparedness in the zinc industry. *Metal. & Chem. Eng.* (July 1, 1918), **19**, 20–22.

COLLITT, B. AND REGAN, W. Analysis of aluminium alloys. *Jour.* Soc. of Chem. Industry (1918), **37**, 91–95.

DAVIS, E. J. Microscopic examination of brass and bronze. *Foundry Trade Jour.* (Apr., 1918), **20**, 185–192.

DE KALB, C. Smelting methods at El Paso. Serial. *Min. & Sci. Press* (May 18, 25, 1918), **116**, 679–684, 711–719.

Deloro Smelting and Refining Co., Deloro, Ont. *Canadian Foundryman* (May, 1918), **9**, 99–105.

Denver and San Francisco to have metal hearings. (U. S. Tariff Commission.) *Min. Congress Jour.* (June, 1918), **4**, 235.

DHAVERNAS, J. Method of separating nickel from nickel-copper alloys. U. S. Patent No. 1266775. *Official Gazette* (May 21, 1918), **251**, 586.

Director Manning shows importance of electrometallurgy. *Metal. & Chem. Eng.* (May 1, 1918) **18**, 441.

DODGE, H. L. Young's modulus of drawn tungsten and its variation with change of temperature, including a determination of the coefficient of expansion. *Physical Rev.* (1918), **11**, 311–315.

DONALD, W. Magnesites and magnesite bricks. *Iron and Coal Trades Rev.* (Mar. 15, 1918), **96**, 282.

DUDELINGEN, V. Alloys, British Patent No. 114852. *Illus. Official Jour.* (June 12, 1918), 1008.

Electric melting of brass. *Iron Age* (May 16, 1918), **101**, 1281.

Electrodeposition of manganese and manganese dioxide. *Metal. & Chem. Eng.* (May 15, 1918), **18**, 507–512.

ESCARD, J. Applications of aluminium pure and in the form of alloys. *Metal Industry* (Apr. 5, 12, 1918), **12**, 261–262, 282–284. Serial.

ESCARD, J. Procedimientos actuales de fabricacion del aluminio. *Revista Minera, Metalurgica y de Ingenieria* (Mar. 8, 16, Apr. 1, 1918), **69**, 124–126, 134–136, 158–160. Serial.

L'evolution de notre electrometallurgie. *Revue Scientific, Industrielle et Commerciale-Métaux et Alliages* (Mar., 1918), **11**, 8–10.

Fine grinding and porous-briquetting of zinc charges. *Eng. & Min. Jour.* (June 29, 1918), **105**, 1175–1176. Letter.

FOOTE, F. W. AND RANSON, R. S. Rapid determination of tungsten. *Eng & Min. Jour.* (May 4, 1918), **105**, 836.

Fulton's electric zinc furnace. *Metal. & Chem. Eng.* (May 15, 1918), **18**, 539–540.

GILLETT, H. W. AND RHOADS, A. E. Melting brass in a rocking electric furnace. *Foundry* (July, 1918), **46**, 314–320.

GREENWOOD, J. N. Constitution and hardness of aluminum bronze. *Foundry* (July, 1918), **46**, 322–325.

HAAN, W. DE. Een neiuwe Nederlandsche uitrinding op metallurgisch gibied. *De Ingenieur* (May, 1918), **33**, 333–351.

COMPLETE GRAPHIC SOLUTION
FOR

KUTTER'S FORMULA

FOR THE FLOW OF WATER

By L. I. HEWES

and

J. W. ROE
Sheffield Scientific School
Yale University

By the use of this diagram and a straight-edge, a complete solution of Kutter's Formula for any given conditions can be obtained in 30 seconds, without the tedious calculations otherwise necessary.

Printed on cloth, 15 by 15 inches. Suitable for office or field use.

PRICE, 50 CENTS

Sent, postpaid, on receipt of price, by

The American Institute of Mining Engineers

29 W. 39th Street, New York, N. Y.

LEHIGH UNIVERSITY

ANNOUNCES

AS A WAR MEASURE

THREE-YEAR COURSES

Covering complete schedule of former four-year courses and entitling graduates to degrees in ENGINEERING AND ARTS AND SCIENCE. Also a

NEW COURSE IN

SHIP CONSTRUCTION

and

MARINE TRANSPORTATION

A COMBINATION OF

ENGINEERING AND ECONOMICS

MILITARY TRAINING

Term Opens September 12

ADDRESS REGISTRAR,
LEHIGH UNIVERSITY
SOUTH BETHLEHEM, PA.

BLUE ENAMELED PIN

GOLD CROSS HAMMERS

SEAL FOB

THE AMERICAN INSTITUTE OF MINING ENGINEERS has adopted no official badge, the possession of which is proof of membership. Numerous designs, however, have been executed for temporary use, and of these three here shown have proven so convenient and attractive, that many members continue to wear them as personal ornaments. To this there is no objection; and these badges will be sent postpaid to Members and Associates on the receipt of the price by New York check, or Postal Money Order, in favor of the Institute, as follows:

Blue Enameled Pin, Silver, $0.75; gold, $2.00; White Enameled Button for officers, gold, $2.00; Cross-Hammers, gold, $2.00; Seal Watch-Fob, silver, $2.25; silver-gilt, $2.75; gold (14 kt.), $14.00.

HANSEN, C. A. Electrolytic zinc. *Min. Jour.* (Apr. 20, Apr. 27, May 4, 1918), **121**, 246–247, 264–265. Serial. (Abstract from A. I. M. E. *Bull.* No. 135.)
HAYNES, E. Stellite. (Alloys of cobalt, chromium, tungsten, and molybdenum.) *Metal. & Chem. Eng.* (May 15, 1918), **18**, 541–542.
l'Industrie de l'aluminum aux Etats-Unis. *l'Industrie Electrique* (Apr. 25, 1918), **27**, 16.
l'Industrie du tungstene en 1917. *Jour. du Four Electrique et de l'Electrolyse* (Apr. 15, 1918), **27**, 89–90.
JOHNSON, F. Alloys of copper, tin and zinc. *Metal Industry* (Apr. 5, 1918), **12**, 268–273. Serial.
KERN, E. F. Effect of iron sulphate in the electrolytic precipitation of copper from sulphate solution with insoluble lead anodes. Amer. Electrochemical Soc., *Advance copy* (1918), **10**, 83–93.
KERN, E. F. Electrolytic refining of tin. Amer. Electrochemical Soc. *Advance copy* (1918), **14**, 145–156.
KIALUND, J. Casting-machine, U. S. Patent No. 1266825. *Official Gazette* (May 21, 1918), **251**, 599.
LANG, H. Classification of furnace slags. *Min. & Sci. Press* (May 4, 1918), **116**, 619–621.
Magnesites and magnesite bricks. *Eng.* (London) (Apr. 26, 1918), **55**, 455.
MATHERS, F. C. Experiments with the copper cyanide plating bath. Amer. Electrochemical Soc., *Advance copy* (1918), **18**, 131–136.
Melting copper alloys. *Foundry* (May, 1918), **46**, 236.
Melting copper in iron ladles. *Model Engr. & Electrician* (Apr. 18, 1918), **38**, 236.
MERICA, P. D. Physical properties of copper and factors which affect them. *Metal Rec. & Electroplater* (Mar.–June, 1918), **4**, 74–80, 119–124, 166–173. Serial.
Metallurgy of copper. *Nature* (Apr. 25, 1918), **101**, 155.
MILLER, D. D. Electrical melting of non-ferrous metals. *Metal Industry* (May 24, 1918), **12**, 399–402.
MILLER, E. C. Should the U. S. foster the domestic production of antimony. *Eng. & Min. Jour.* (June 15, 1918), **105**, 1088–1089. (Smelting antimony.)
MILLINGTON, E. Influence of small quantities of some metallic elements on the mechanical properties of brass. *Jour.* of the Soc. of Chem. Ind. (May 31, 1918), **37**, 149–155.
MILNES, P. R. Concentration and smelting at Humboldt, Arizona. *Arizona Mining Jour.* (June, 1918), **2**, 17–22.
New electric zinc smelting process. *Metal Rec. & Electroplater* (June, 1918), **4**, 155.
New manganese standard alloys. *Iron Age* (May 23, 1918), **101**, 1326.
New method of determining copper. *Min. & Sci. Press* (May 25, 1918), **116**, 725–726.
Nitre cake for pickling brass. *Metal Rec. & Electroplater* (June, 1918), **4**, 158.
Oxygen and sulphur in the melting of copper cathodes. *Eng. & Min. Jour.* (July 6, 1918), **106**, 15.
PETERS, J. Some brass foundry notes. *Metal Rec. & Electroplater* (June, 1918), **4**, 150–151.
Platinum in war times and its working. *Metal Rec. & Electroplater* (Mar.–May, 1918), **4**, 87–90, 130–133. Serial.
Platinum taken by war board. *Oil, Paint & Drug Reporter* (June 17, 1918), **93**, 69.
Properties of brasses. *Mech. World* (Apr. 26, 1918), **63**, 197.
Pure sheet nickel, cold rolled. *Metal Industry* (Apr. 5, 1918), **12**, 273.
Qualitative tests for the rarer metals. *Mining American* (Apr. 1, 1918), **77**, 3–4.
Recent zinc patents. *Min. & Sci. Press* (June 15, 1918), **116**, 824.
Reducing zinc loss in brass making. *Min. & Sci. Press* (June 22, 1918), **116**, 854.
RIGG, GILBERT. Notes on a new method of roasting zinc sulphide ores. *Mining Mag.* (1918), **18**, 285–287.
Roasting furnace for zinc concentrates. *Mining Rev.* (Apr. 5, 1918), **10**, 198.
Rocking electric furnace for brass melting. *Industrial Management* (July, 1918), **56**, 70.
RULTENBER, L. M. Early brass days in Connecticut. *Metal Industry* (May, 1918), **16**, 218–219.
Rysslands Koppar-production. *Teknisk Tidkrift* (May 18, 1918), 244–245.
SAHLIN, A. Furnaces, British Patent No. 114751. *Illus. Official Jour.* (June 12, 1918), 975.
SCHOELLER, W. R. Discussion on blast furnace smelting of stibnite, with considerations on the metallurgy of antimony. *Bulletin* Inst. of Min. and Metal. (1918), **162**, 1–7.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Acids and Ammonia
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Acid, Sulphuric
Illinois Zinc Co., Peru, Ill.

Agitators
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Amalgamators
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corpn., 115 Broadway, New York City.

Asbestos
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Asbestos Materials
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Assay Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway New York City.

Axles, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Balances and Weights
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ball and Tube Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Bearings, Ball
Gwilliam Co., 253 W. 58th St., New York City.

Bearings, Roller
Gwilliam Co., 253 W. 58th St., New York City.

Belting, Conveyor
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Belting, Elevator
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Belting, Transmission
Goodrich Rubber Co., B. F., Akron, O.

Bins, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Blasting Powder (See Powder, Blasting)

Blasting Supplies
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Blowers
General Electric Co., Schenectady, N. Y.

Blowpipe Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Brake Blocks
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Brick, Fire
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Buckets, Elevator
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Burners, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Burners, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway New York City.

Cableways
Flory Mfg. Co., S., Bangor, Pa.
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Cages, Hoisting
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Cages, Self Dumping and Plain
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Car Lifts, Automatic
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Carbide Lamps
Macleod Co., Bogen St., Cincinnati, Ohio.

Cars, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Castings, Brass
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Castings, Iron
Fuller-Lehigh Co., Fullerton, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Caustic Soda
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Cement Blast Guns (See Guns, Cement)

Cement Machinery
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Cements, Refractory
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Chains
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Chemical Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Chemicals
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Chrome Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Ore (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chute Plates & Launder Liners
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Chutes
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Classifiers
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo
Deister Concentrator Co., Fort Wayne, Ind.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Coal and Ash Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Mining Machines
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coal Mining Plants
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Storage and Rehandling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coatings, Roof
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Collectors, Dust
Macleod Co., Bogen St., Cincinnati, Ohio.

Compass, Maas Patent Drill Hole
Derby, Jr., E. L., Agent, Ishpeming, Mich.

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Concentrators
Colorado Iron Works Co., Denver, Colo.
Deister Concentrator Co., Fort Wayne, Ind.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Condensers, Surface
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Contractors, Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Converters, Copper
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Converters, Electric, Rotary
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Conveyors, Belt
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Conveyors, Cable Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Chain Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Pan or Apron
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Screw
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Core Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coverings, Pipe and Boiler
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Crucibles
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Crushers, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Crushers, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Boradway, New York City.

Crushing Roll Parts
American Manganese Steel Co., McCormick Bldg., Chicago Ill.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Crushing Rolls (See Rolls, Crushing)
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Cupro-Magnesium Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Cupro-Vanadium
Primos Chemical Co., Primos, Pa.

Cyanide
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Cyaniding Equipment
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Dead Burned Magnesite
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Dewaterers
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

Dredging Machinery
Flory Mfg. Co., S., Bangor, Pa.

Drill Hole Compass (See Compass, Drill Hole)

Drills, Core
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Diamond
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Electric
Denver Rock Drill Mfg. Co., Denver, Colo.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Drills, Hammer
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Prospecting
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Rock
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Dryers, Ore
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.

Dryers, Rotary
Fuller-Lehigh Co., Fullerton, Pa.

Dryers, Sand and Gravel
Macleod Co., Bogen St., Cincinnati, Ohio.

Dumps, Rotary
Wood Equipment Co., McCormick Bldg., Chicago, Ill.

Dynamite
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Dynamos (See Generators, Electric)

Electrical Machinery
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Elevators, Bucket
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Emery Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

End Loaders (See Loaders, End)

Engines, Gas and Gasoline
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Engines, Haulage
Holmes & Bros., Inc., Robt., 80 N. Hazel St., Danville, Ill.

Engines, Hoisting
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 80 N. Hazel St., Danville, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Engines, Oil
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Engines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Explosives
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Fans, Ventilating
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Feeders, Ore
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Ferro-Chrome
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Molybdenum
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Ferro-Silicon
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Tungsten
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Ferro-Vanadium
Primos Chemical Co., Primos, Pa.

Filtering Paper
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Filters
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Fire Clay
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Flotation, Oil
Colorado Iron Works Co., Denver, Colo.

Flue Welding Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Fluorescent Calcium Tungstate
Primos Chemical Co., Primos, Pa.

Fluorspar (Domestic and Foreign)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Forges, Oil and Rivet
Macleod Co., Bogen St., Cincinnati, Ohio.

Forgings, Heavy
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Fuller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Furnaces, Assay
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Electric
General Electric Co., Schenectady, N. Y.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Furnaces, Flue Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Lead
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Mechanical Roasting
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Furnaces, Muffle
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Reverberatory
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Smelting
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Furnaces, Tire Heating
Macleod Co., Bogen St., Cincinnati, Ohio.

Gears
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Generators, Acetylene Welding and Cutting
Macleod Co., Bogen St., Cincinnati, Ohio.

Generators, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Grinders, Sample
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Grizzly & Riffle Bars (For Hydraulic Mines)
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Guns, Cement
Macleod Co., Bogen St., Cincinnati, Ohio.

Guns, Concrete
Macleod Co., Bogen St., Cincinnati, Ohio.

Gyratory Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Hangers, Mine
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Hitchings Mine Car
Macomber & Whyte Rope Co., Kenosha, Wis.

Hoists, Electric
Allis-Chalmers Mfg. Co., Milwaukee. Wis.
Flory Mfg. Co., S., Bangor, Pa.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoists, Skip
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Hoists, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoppers, Weigh
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Hose, Air
Denver Rock Drill Mfg. Co., Denver, Colo.
Goodrich Rubber Co., B. F., Akron, O.

Hydrated Ferric Oxide (For Gas Purification)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Hydraulic Mining Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Insulators, Third Rail
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Jackets, Water
Traylor Engineering & Mfg. Co., Allentown, Pa.

Jaw Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Jigs
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Laboratory Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Lamps, Acetylene
Macleod Co., Bogen St., Cincinnati, Ohio.

Lamps, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Lead Acetate
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Linings, Ball and Tube
Traylor Engineering & Mfg. Co., Allentown, Pa.

Linings, Brake
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Litharge
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Loaders, End
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Loading Booms
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Locomotives, Compressed Air
General Electric Co., Schenectady, N. Y.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Electric Trolley
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Locomotives, Gasoline
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Steam
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Storage Battery
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Low Carbon Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesia Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesite Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesium Metal (Ingots and Powder.)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnetic Pulleys (See Pulleys, Magnetic)

Manganese Dioxide (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Manganese Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Meters, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Mica
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Mills, Ball, Tube and Pebble
Allis-Chalmers Mfg. Co., Milwaukee, Wis
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Mills, Chilean
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Mills, Stamp
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n. 115 Broadway, New York City.

Mine Car Hitchings (See Hitchings, Mine Car).

Molybdate of Ammonia
Primos Chemical Co., Primos, Pa.

Molybdate of Calcium
Primos Chemical Co., Primos, Pa.

Molybdate of Soda
Primos Chemical Co., Primos, Pa.

Molybdenum Metal
Primos Chemical Co., Primos, Pa.

Molybdenum Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Molybdic Acid
Primos Chemical Co., Primos, Pa.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Muffles
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ore-Bedding Systems
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Milling Machinery
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Ores, Buyers and Sellers of
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Oxy-Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Packings, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.
Goodrich Rubber Co., B. F., Akron, O.

Painting Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Pipe Insulations
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Plate Metal Work
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Platinum Wire, Foil & Ware
Heil Chemical Co., Henry, 210-214 S. 4th St. St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Powder, Blasting
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Powdered Coal Equipment
Fuller-Lehigh Co., Fullerton, Pa.

Power Transmission Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Presses, Filter
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pulleys, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Pulverizer Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Pulverizers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Pulverizers, Coal and Coke
Fuller-Lehigh Co., Fullerton, Pa.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pulverizers, Ore
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Acid
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Hydraulic Pressure
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Pneumatic Air Lift
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Pumps, Power
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Sand
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pumps, Sinking
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Stuff
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Track
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pyrometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Quarrying Machinery
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Quicksilver
Beer, Sondheimer & Co., 61 Broadway, New York City.

Refractories
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Respirators
Goodrich Rubber Co., B. F., Akron, O.
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.

Revolving Screen Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rods, Drill
Colonial Steel Co., Keystone Bldg., Pittsburgh. Pa.

Roller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rolls, Crushing
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Roofings, Asbestos and Rubber-type
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Rope, Wire
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rope Fastenings, Wire
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rubber Goods, Mechanical
Goodrich Rubber Co., B. F., Akron, O.

Samplers, Ore
Mine and Smelter Supply Co:, 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Scorifiers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Screens, Bar
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Screens, Perforated Metal
Jeffrey Mfg. Co., 902 N. 4th St., Columbus. Ohio.

Screens, Revolving
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Screens, Shaking
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Separators, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Shaft Sinking and Development Work
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Sharpeners, Drill
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Silica Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Skip Hoists (See Hoists, Skip)

Slings, Wire Rope
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Smelters
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Smelting Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Soda Ash
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Spelter
Illinois Zinc Co., Peru, Ill.

Spiegeleisen
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Sprockets
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Stamp Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Steel, Crucible
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.

Steel, Drill, Hollow and Solid
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Steel, Tool
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.

Stokers
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Tables, Concentrating (See Concentrators)

Test Lead
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thawers, Switch
Macleod Co., Bogen St., Cincinnati, Ohio.

Thermometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thickeners, Slime
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.

Tipple Machinery Equipment
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Torches, Cutting and Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Towers and Bridges, Stocking and Reclaiming
Robins Conveying Belt Co., Park Row Bldg., New York City.

Tramways, Wire Rope, Aerial
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Transformers, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Traps, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Tungstate of Ammonia
Primos Chemical Co., Primos, Pa.

Tungstate of Soda
Primos Chemical Co., Primos, Pa.

Tungsten Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Tungsten Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Tungsten Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Tungstic Acid
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Turbines, Hydraulic
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Valves, Pump
Goodrich Rubber Co., B. F., Akron, O.

Vanadate of Ammonia
Primos Chemical Co., Primos, Pa.

Vanadic Acid
Primos Chemical Co., Primos, Pa.

Vanadium Chloride
Primos Chemical Co., Primos, Pa.

Vanadium Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Ventilating Fans (See Fans, Ventilating)

Wagon Loaders
Jeffrey Mfg. Co., 902 N. 4th St., Columbus Ohio.

Weigh Hoppers (See Hoppers, Weigh)

Wheels
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Wheels, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Wire, Iron, Steel and Copper
Roebling's Sons Co., John A., Trenton, N. J.

Wire Mechanism (Lever Control)
Gwilliam Co., 253 W. 58th St., New York City.

Wire Rope (See Rope, Wire)

Wires and Cables, Electrical
General Electric Co., Schenectady, N. Y.
Goodrich Rubber Co., B. F., Akron, O.
Roebling's Sons Co., John A., Trenton, N. J.

Zinc Dust
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Zinc Sheet
Illinois Zinc Co., Peru, Ill.

ALPHABETICAL LIST OF ADVERTISERS

(With Summary of Products)

See pages 45–51 *for Classified List of Mining and Metallurgical Equipment*

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

ALPHABETICAL LIST OF ADVERTISERS (Continued)

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

OCTOBER, 1918

Bulletin of the American Institute of Mining Engineers

PUBLISHED MONTHLY

SPECIAL FEATURES

Bulletin of the American Institute of Mining Engineers

No. 142 OCTOBER 1918

CONTENTS

CURRENT MATTERS

TECHNICAL PAPERS

ADVERTISING

"Among those present" at Broadmoor Hotel,
Colorado Springs, September, 1918.

BULLETIN OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

PUBLISHED MONTHLY

No. 142 OCTOBER 1918

Published Monthly by the American Institute of Mining Engineers at 212-218 York St., York, Pa., H. A. Wisotzkey, Publication Manager. Editorial Office, 29 West 39th St., New York, N. Y., BRADLEY STOUGHTON, Editor. Cable address, "Aime," Western Union Telegraph Code. Subscription (including postage), $10 per annum; to members of the Institute, public libraries, educational institutions and technical societies, $5 per annum. Single copies (including postage), $1 each; to members of the Institute, public libraries, etc., 50 cents each.

Entered as Second Class matter January 28, 1914, at the Post Office at York, Pennsylvania, under the Act of March 3, 1879.

MILWAUKEE MEETING, OCT. 8 TO 11, 1918

The 118th meeting of the Institute, which has been arranged primarily for the benefit of the Institute of Metals Division and of those members who are particularly interested in iron and steel, will be held in the Milwaukee Auditorium, Milwaukee, Wis., on Oct. 8 to 11, 1918. This date has been selected because at that time, and at the same place, the American Foundrymen's Association and the American Malleable Castings Association will hold meetings.

A notable exhibit of metallurgical and mechanical processes and products, at which over 165 firms will be represented, has been arranged in Machinery Hall, of the Auditorium Building. Wherever practicable, the machinery will be in operation.

The program of the Institute's sessions was published in *Bulletin* 141. A special announcement of the meeting, together with a program of the sessions of the American Foundrymen's Association, has been mailed to every member who was thought to be directly interested in the meeting.

A report of the meeting and of the discussion of papers will be printed in the December *Bulletin*.

PROCEEDINGS OF THE ONE HUNDRED SEVENTEENTH MEETING OF THE INSTITUTE, COLORADO

September 1 to 6, 1918

COMMITTEE IN CHARGE

Spencer Penrose, *Chairman* — George M. Taylor, *Vice-Chairman*
A. E. Carlton, *Chairman Finance Committee* — J. Dawson Hawkins, *Secretary*

DENVER

Finance
T. B. Stearns
Richard A. Parker
T. B. Burbridge

Arrangement
Dave G. Miller
Frank Bulkley
Geo. E. Collins

Entertainment
F. H. Bostwick
F. E. Shepard
Howland Bancroft
B. P. Morse
J. G. Perry

Ladies
Mrs. T. B. Stearns, *Chairman*
Mrs. C. Loughridge
Mrs. H. Bancroft
Mrs. G. Bancroft
Mrs. W. D. Leonard
Mrs. C. Chase
Mrs. F. H. Bostwick
Mrs. F. Bulkley

COLORADO SPRINGS

Finance
A. E. Carlton
Spencer Penrose
George M. Taylor
A. L. Blomfield, *Treasurer*

Registration
Loren C. Lennox
Horace F. Lunt
J. M. Tippett

Arrangement and Entertainment
George M. Taylor
J. D. Hawkins
A. E. Carlton
G. H. Clevenger
A. L. Blomfield
Thomas B. Crowe
E. P. Arthur
Etienne A. Ritter

Ladies
Mrs. G. M. Taylor, *Chairman*
Mrs. G. H. Clevenger
Mrs. S. Penrose
Mrs. J. D. Hawkins
Mrs. L. C. Lennox
Mrs. H. F. Lunt
Mrs. E. A. Ritter
Mrs. L. S. Harner
Miss F. Dickerman
Mrs. C. L. Tutt
Mrs. A. E. Carlton
Mrs. A. L. Blomfield
Mrs. J. M. Tippett
Mrs. E. C. van Diest
Mrs. W. Strieby
Mrs. C. L. Bailey
Mrs. E. P. Shove
Mrs. F. G. Peck
Mrs. F. D. Pastorius

CRIPPLE CREEK

Thomas B. Crowe
E. P. Arthur, Jr.
N. S. Greensfelder
A. E. Carlton
B. F. Hill
F. G. Willis
Norris E. Eads
W. E. Ryan
Fred Jones
F. D. Smale
J. H. Haynes
L. W. Lennox
M. R. Valentine

PUEBLO

J. F. Welborn
H. B. Carpenter
L. B. Eames
F. Robinson

It was peculiarly fitting that the American mining engineer, holding a war-time conference, should have chosen for the scene of the meeting the State of Colorado, better endowed, perhaps, than any other State to fill the need for war minerals. The 117th meeting of the American Institute of Mining Engineers reflected in both technical and social features an enthusiastic effort to support every aim of a war-winning character.

Although avoiding any lavishness of display or extravagant entertainment, inappropriate to the times, the Colorado members of the Institute provided a week of well varied instruction and recreation such as can only be offered amid the snow-peaked mountains of the State. The fact that during all but one day of the week "nature's dewy tear drops" fell intermittently failed to detract from the successful execution of the Committee's plans.

Two days in Denver and four in Colorado Springs, from which excursions were made to the Cripple Creek district and Pueblo, comprised the program. On Sunday, Sept. 1, the visiting members and their guests arrived in Denver. Registration at the headquarters in the Brown

Palace Hotel showed a total of 275 on Sunday night, which number was increased to more than 500 before the close of the meeting.

Sunday was spent in a visit to the City Park Museum in Denver: attendance at a special recital on the municipal organ, said to be the largest and most complete orchestral organ in the world; a special evening display of the electric fountain at City Park, and automobile processions through the City Parks and Boulevards.

On Monday, Sept. 2, shortly after nine o'clock, the first technical session of the meeting was held. Thomas B. Stearns presided and directed the discussion on Metallurgy.

Two hours later, the delegates, conveyed by automobiles, were inspecting the electric ferro-manganese furnaces of the Iron Mountain Alloy Co., at Utah Junction, three miles from Denver. This plant, it was said, is being used experimentally for war purposes preparatory to larger developments. It is in many ways similar to the type of plant at Anaconda, though lacking some of the modern improvements.

Monday noon a luncheon was served to the members, and about one hundred ladies who were guests, in the Denver Club. Following the luncheon, Thomas B. Stearns, Chairman of the Denver Finance Committee of the convention, welcomed the party to Denver and made a bit of history by the remark that inclement weather had come "for the first time in 365 days." Mr. Stearns introduced Mayor W. F. R. Mills, who explained some of the scenic features of Denver and then welcomed the delegates with the words "the City is yours." President Sidney

J. Jennings of the Institute thanked Mayor Mills and the Denver members on behalf of the guests.

Immediately after luncheon the party left in automobiles for Lookout Mountain and Genesee Park, a unique municipal development in that it lies 20 miles from the administrative center. En route, many of the guests were taken to the Herold Pottery Works, at Golden, for an inspection of the process of manufacturing high-grade chemical porcelain.

Following the Lariat trail on Lookout Mountain, over roads built by the City of Denver, the party reached the summit in about one hour and a half. Here is the grave of Col. William F. Cody (Buffalo Bill) covered by native rocks and stones. Many of the party added their pieces to the monument, rough hewn as the man himself, by placing a stone on his resting place.

In the course of the afternoon's tour, which included a trip through Genesee Park and along the banks of the beautiful Bear Creek, a thunder storm broke around the mountains, the greater part being in the clouds beneath the summit of Lookout. It was possible to look down upon the storm from the high altitude and after a few minutes to observe the sun shining through the great white clouds as they parted.

On Monday evening a dinner was served informally in the Denver Country Club to some 300 persons. Following dinner, F. B. Burbridge of Denver established a record as toastmaster by limiting six speakers to a total of 45 minutes. The speakers were Sidney J. Jennings, E. P. Mathewson, H. Foster Bain, C. W. Goodale, Thomas B. Stearns, and Horace V. Winchell.

On the following morning the party journeyed by motor and train to Colorado Springs, arriving at the meeting headquarters, the Broadmoor Hotel, at about noon. At one o'clock a splendid luncheon was served in the hotel dining rooms.

An hour later a memorial service for Dr. James Douglas, in the theatre of the hotel, was attended by every member. President Sidney J. Jennings presided and, after paying a tribute to Dr. Douglas, introduced E. P. Mathewson, representing the Canadian Mining Institute, who, as a fellow Canadian, told of Dr. Douglas' early life in the Dominion; Walter Renton Ingalls, editor of the *Engineering and Mining Journal*, representing the Mining and Metallurgical Society of America, who spoke of Dr. Douglas as a scientist; and T. H. O'Brien, representing the Phelps-Dodge Corporation. The words of these men made a deep impression upon those present. (A full report of this service is printed on a later page.)

A series of motion pictures, showing the adaptation to industry of soldiers crippled or disabled in war, were later shown in the theatre. These pictures were made by the Canadian Government and loaned to the Institute by the U. S. Department of the Interior. The opportunities thus far opened to cripples from the war, as pictured, surprised many and, as indicated by informal remarks, strengthened their desire to provide "a better place for the cripple than he had held before and to give him the preference."

The remainder of Tuesday afternoon was given over to two simultaneous technical sessions, one on Ore-dressing and Cyanidation, presided over by G. H. Clevenger, and the other on Coal and Coke, at which A. E. Carlton presided. At this latter session many members of the Rocky Mountain Coal Mining Institute were present, though not holding

a joint meeting with the Institute, as planned, because of the absence of their president.

The Ladies' Committee of Colorado Springs furnished an interesting program during the time of the technical sessions, which included visits by automobile to the Garden of the Gods and Glen Eyrie, and tea in the Castle of the Glen. Throughout the week the Ladies' Committee provided many features of special interest to the visiting ladies.

During Tuesday evening a formal reception and dance was held in the Broadmoor Hotel, continuing until after midnight.

Despite a heavy mist on Wednesday morning, Sept. 4, a train of mining engineers was ready for a trip to the Cripple Creek District, at 8 o'clock. A special train on the Colorado Midland Railroad was provided by the hosts, and about 11 o'clock the party was skirting the mountainside in sight of the District. The little town of Altman, said to be the highest incorporated town in the world, was passed and a little later the train reached Victor, where a luncheon was served in a great tent, pitched near the tracks, by the Portland Gold Mining Co. The party then spent some two hours inspecting the Independence mill. During the visit some of the guests were taken through the Cresson mine, producing the highest-grade ore of the district, and others walked or motored down the deserted streets of the town. The romances, the tragedies and the disappointments of gold mining in Cripple Creek were all in evidence, but only as memories. The business of gold mining no longer reads like a story book in Cripple Creek.

The special train returned to Colorado Springs at 6 o'clock. That evening, Dr. Richard B. Moore opened a technical session on Geology and Mining in the theatre of the Broadmoor Hotel, with a series of experiments with radium, presented in a semi-popular manner, and indicating the uses to which radium has been put in the war. This was followed by the discussion of other subjects related to the topic of the evening, H. Foster Bain presiding. During this session, the Secretary presented the following resolution, recommended by the Board of Directors, which was unanimously passed by the members:

RESOLVED: That the following minute be entered in the Proceedings of this meeting, and that a copy thereof, signed by the President and Secretary, be sent to the family of Dr. Douglas.

Through the death of James Douglas, this Institute, in common with the professions of mining and metallurgy, and the representatives of liberal learning, technical education, wise philanthropy, and social progress throughout the world, is called to deplore the loss of an inspiring leader, tireless laborer, loyal and helpful friend.

Dr. Douglas' sympathies, quick toward every worthy cause, were especially drawn toward the Institute, because its chief purpose, namely, the free interchange of professional knowledge and experience, commanded his life-long allegiance, not only as a dictate of wise policy, but also as the result of an irresistible generous impulse. He gave freely; he gave "himself with his gift;" and his reward was known of all, even before the record of it, in the gratitude and grief of innumerable friends, was signed and sealed by his death. To them he was not only great, but dear.

Although greeted by a drizzling rain on the morning of Thursday, Sept. 5, and the prediction that snow was falling on the mountain, some 150 of the delegates set out early to make the ascent of Pikes Peak by automobile. The first motor car reached the top of the Peak through a heavy snow fall in about four hours, and before the last car of the party had turned back there was five inches of snow on the ground. Lunch was

served at Glen Cove on the Pikes Peak Highway and, despite the obstacles of the trip, those courageous enough to take it were delighted with the novelty of the adventure. During the afternoon, those who had remained at headquarters and some of those returning from the Peak, visited the Golden Cycle mill on the outskirts of Colorado Springs. Here they observed the precipitation of gold on zinc and the cyanidation of low-grade ores on a vast scale.

Thursday evening was perhaps the busiest single period of the week. Five meetings were held between 8 o'clock and midnight, all of the greatest interest. The first meeting featured a series of motion pictures showing mining and milling methods, welfare work, and the patriotic impulse in the daily routine of the Inspiration Consolidated Copper Co., at Inspiration, Arizona. Dr. L. D. Ricketts supplemented the title explanations of the "movies" with concise facts that made the exhibition almost as instructive as a visit. The pictures were models in the field of cinematography, even though made, in some instances, under handicaps.

President Jennings, at 9 o'clock, presided at a meeting in memory of the 15 members of the Institute known to have made the supreme sacrifice in the war. A service flag of the Institute, showing 845 in service, hung from the stage, and as Secretary Stoughton read the records of those who have died or been killed in the service of the Allies, their pictures were thrown upon the screen. Everyone attending at the Convention joined in paying tribute at this service. (A record of this meeting is printed on a later page.)

During the remainder of the evening, three technical sessions were held simultaneously, the principal one being on Petroleum, presided over by R. D. George. The others were a continuation of the discussion of electrostatic precipitation, opened at Monday morning's meeting, and a session on coal mining problems of today.

Friday morning dawned auspiciously for the trip to Pueblo, and an elaborate program of entertainment for the ladies. The majestic hills forming a background for the hotel were bathed in sunlight and the air was mild and balmy. A special train on the Colorado & Southern Railroad left the Springs at 9 o'clock, taking the party south over the plains to Pueblo and thence to Minnequa, where the works of the Colorado Fuel and Iron Co. are situated.

After an hour's visit to the enormous byproduct coke ovens, installed in July, the members and guests were given luncheon in the company clubhouse situated on the edge of a small lake. The desire of most of the party to spend all their time in the works, which have established, with other steel works, such an important place in war-winning fields, shortened the lunch period, and automobiles were pressed into service in scores to return the delegation to the works. During the afternoon everyone was given an opportunity to inspect the Bessemer and open-hearth processes. Some 40 executives of the plant took groups of the engineers on a thorough tour of inspection. The maximum monthly record for these works in production of steel is 55,000 tons. Some 6000 men are employed.

The return to Colorado Springs was made on the special train about 6 o'clock. The advantages of travel by special train, which was achieved so efficiently by the Colorado Committee, relate to more than mere transportation. The opportunity for social intercourse affords a chance to form many new acquaintances, which are renewed year after year

among the profession, and are often cemented into warm friendships.

During Friday, the ladies of the party were driven by automobile to Crystal Park, where a picnic lunch was served, and at 4.30 o'clock Mrs. Spencer Penrose entertained them at a garden party at El Pomar.

To banquet with a State Food Administrator as toastmaster might seem a dull form of amusement, but the banquet on Friday night, in the dining room of the Broadmoor, which marked the close of the 117th meeting, was a lively finale for the week. Twenty-four songs, printed in booklet form and most of them of a patriotic character, kept the spirits of the party high. A quartet led the singing and their efforts were assisted by various amateur song writers among the diners. Not the least capable among these was one who immortalized the Thursday morning push to the top of the Peak by the following verse—sung to the tune of "There's A Long, Long Trail"—

There's a long, long trail awinding
Up to the top of Pikes Peak,
Where the sun is always shining
And the clouds don't leak.
There's a long, long time of waiting
Until the lunch box comes through,
Till all the mining engineers
Are sitting down to chew.

Thomas B. Stearns made an inimitable toastmaster; he was introduced by A. E. Carlton.

President Sidney J. Jennings, the first speaker, stated that the aim of the Institute now is to win the war, and completely defeat the Hun. Then he told of some of the work being done by members of the Institute in important posts, and closed with a warning to "steel our hearts against the insidious propaganda of the German Government, which is sure to come, and perhaps very soon when they realize the tide has turned against them." He thanked the Institute's hosts for the entertainment which he characterized as delightful in every respect.

Captain Louis Benett, representative of André Tardieu, French High Commissioner of France to the United States, electrified the guests by telling them that the present need is not for transportation or food but "to pour as many tons of steel as you have on the heads of your enemy." Tremendous applause greeted his statement that "America is doubtless France's best friend."

Philip N. Moore then spoke of the importance of the mining engineer in every walk of life, and E. P. Mathewson pictured the work of women in Canadian mining centers. He said they do all kinds of work around smelters except heavy lifting, and that when women take their place in American mining it will be found that "they will do the job better than the men ever did."

C. W. Goodale, who first came to Colorado as a mining engineer in 1876, stated the cardinal necessities to the proper administration of efficient mining, as regards the employe.

Secretary Bradley Stoughton told the guests of the auspicious beginning of the Washington, D. C., section of the Institute. He then urged the greater use of the library in the Engineering Building in New York, although stating that it is now doing work for more mining engineers and metallurgists than for any other of the great societies in the building. He then explained the value of the Index which first appeared in the

September Bulletin; gave new honor to the Woman's Auxiliary for their war work, especially the founding of a dispensary in France, and expressed the great appreciation of the members and friends for the untiring and thorough efforts of the Colorado members in making the meeting highly successful, none, he said, having exceeded it in varied features.

Horace V. Winchell spoke on the Russian situation, and Dr. L. D. Ricketts closed the banquet, telling, in blank verse, the career of the mining engineer.

Dancing followed the banquet and the ballroom was filled till a late hour, as it had been on each of the four evenings spent in the Springs.

On Saturday, Sept. 7, several of the engineers went to the Leadville district to view the production of the many war minerals of that locality, but most of the party started for their homes on Saturday morning.

TECHNICAL SESSIONS

Session on Metallurgy

The session on metallurgy was held on Monday morning, Sept. 2, 1918, at the Brown Palace Hotel, Denver, Mr. T. B. Stearns presiding. The following papers were presented:

Electrolytic Zinc. By C. A. Hansen. (Presented by author and discussed by Sidney J. Jennings and the author. Written discussion by J. L. McK. Yardley.)

The Manufacture of Ferro-alloys in the Electric Furnace. By R. M. Keeney, (Presented by the author.)

The Metallography of Tungsten. By Zay Jeffries. (Presented by title. Written discussion by Sir Robert A. Hadfield.)

The Condensation of Zinc from Its Vapor. By C. H. Fulton. (Presented by title and discussed by E. E. Thum.)

Electrostatic Precipitation. By O. H. Eschholz. (Presented by title. Written discussions by Harmon E. F. Fisher and G. B. Rosenblatt.)

Oxygen and Sulphur in the Melting of Copper Cathodes. By S. Skowronski. (Presented by title.)

The Relation of Sulphur to the Overpoling of Copper. By S. Skowronski. (Presented by title and discussed by Philip L. Gill.)

The Practice of Antimony Smelting in China. By C. Y. Wang. (Presented by title.)

Session on Coal and Coke

The session on coal and coke was held on Tuesday afternoon, Sept. 3, Mr. A. E. Carlton presiding. The following papers were presented:

The Byproduct Coke Oven and Its Products. By William Hutton Blauvelt. (Presented by title and discussed by Graham Bright, S. A. Moss, John I. Thompson.)

The Use of Coal In Pulverized Form. By H. R. Collins. (Presented by the author and discussed by E. A. Holbrook, Captain Walter Graham, Bradley Stoughton, Milnor Roberts, Erskine Ramsay, H. N. Eavenson and the author.)

Carbocoal. By C. T. Malcolmson. (Presented by the author. Written discussions by F. W. Sperr, Jr., N. W. Roberts, J. M. Fitzgerald, W. R. Cox, F. R. Wadleigh, Charles Catlett, C. M. Barnett.)

Development of the Coke Industry in Colorado, Utah and New Mexico. By F. C. Miller. (Presented by the author.)

Price Fixing of Bituminous Coal by the U. S. Fuel Administration. By Cyrus Garnsey, R. V. Norris and J. H. Allport. (Presented by the Secretary.)

Coal Mining in Washington. By F. A. Hill. (Presented by title. Written discussion by Milnor Roberts.)

Session on Ore-dressing and Cyanidation

The session on ore-dressing and cyanidation was held on Tuesday afternoon, Sept. 3, Mr. G. H. Clevenger presiding. The following papers were presented:

The Effect of Oxygen upon the Precipitation of Metals from Cyanide Solutions. By T. B. Crowe. (Presented by the author and discussed by J. V. N. Dorr, A. L. Blomfield, C. A. Hansen, G. M. Taylor, L. H. Dushak.)

Roasting for Amalgamating and Cyaniding Cripple Creek Sulphotelluride Gold Ores. By A. L. Blomfield and M. J. Trott. (Presented by the authors and discussed by J. V. N. Dorr and J. M. Tibbetts.)

The Tailing Excavator at the Plant of the New Cornelia Copper Co., Ajo, Ariz. By Frank Moeller. (Presented by the author and discussed by E. P. Matthewson, C. A. Hansen and Frank Moeller.)

The Elko Prince Mine and Mill. By J. V. N. Dorr and C. D. Dougan. (Presented by the authors.)

Crushing Resistance of Various Ores. By L. W. Lennox. (Presented by the author and discussed by R. B. T. Kiliani, C. A. Hansen, V. A. Stout, Rudolf Gahl and the author.)

Hand-sorting of Mill Feed. By R. S. Handy. (Presented by title. Written discussions by A. Stanley Hill, W. L. Ziegler, L. O. Howard, Clarence A. Wright, D. C. Bard, S. A. Easton, F. A. Thomson, W. H. Linney and the author.)

The Automatic Separation of Solution from Solids in the Hydro-metallurgical Treatment of Ore Pulps. By Bernard MacDonald. (Presented by title.)

Fine-grinding Cyanide Plant of Barnes-King Development Co. By J. H. McCormick. (Presented by title.)

Session on Economic Geology and Mining Practice

The session on economic geology and mining practice was held on Wednesday evening, Sept. 4, Mr. H. Foster Bain presiding. The following papers were presented:

Radium. By R. B. Moore. (Presented by the author and illustrated by experiments. Discussed by Dr. W. A. Schlesinger, H. J. Seaman, S. A. Moss and the author.)

Molybdenite Operations at Climax, Colorado. By D. F. Haley. (Presented by the author.)

Engineering Problems Encountered During Recent Mine Fire at Utah-Apex Mine, Bingham Canyon, Utah. By V. S. Rood and J. A. Norden. (Presented by V. S. Rood and discussed by George S. Rice and V. S. Rood.)

The Relation of Sulphides to Water Level in Mexico. By P. K. Lucke. (Presented by title.)

The Mechanics of Vein Formation. By Stephen Taber. (Presented by title.)

Pyrite Deposits of Leadville, Colorado. By Howard S. Lee. (Presented by the author.)

Fireproofing Mine Shafts of the Anaconda Copper Mining Co. By E. M. Norris. (Presented by title.)

Air Blasts in the Kolar Gold Field, India. By E. S. Moore. (Presented by title.)

Man Power. By J. Parke Channing. (Presented by title.)

Session on Petroleum

The session on petroleum was held on Thursday evening, Sept. 5, Mr. R. D. George presiding. The following papers were presented:

Gaging and Storage of Oil in the Mid-Continent Field. By O. U. Bradley. (Presented by the author and discussed by C. B. Ponney.)

An Interpretation of the So-called Paraffin Dirt of the Gulf Coast Oil Fields. By A. D. Brokaw. (Presented by title. Written discussions by W. E. Wrather, E. G. Woodruff and Lee Hager.)

The Theory of the Volcanic Origin of Salt Domes. By E. L. DeGolyer. (Presented by title. Written discussion by J. A. Udden and E. L. DeGolyer.

A Concrete Example of the Use of Well Logs. By Mowry Bates. (Presented by the author and discussed by C. A. Hammill, Dorsey Hager and the author.)

Oil in Southern Tamaulipas, Mexico. By Ezequiel Ordonez. (Presented by title. Written discussion by V. R. Garfias.)

Geology of the Oil Fields of North Central Texas. By Dorsey Hager. (Presented by the author and discussed by C. A. Hammill, C. H. Beal, M. I. Goldman, J. S. Lewis, A. C. Dennis and the author. Written discussion by W. E. Pratt.)

Staggering Locations for Oil Wells. By R. H. Johnson. (Presented by title and discussed by J. L. Lewis.)

Losses of Crude Oil in Steel and Earthen Storage. By O. U. Bradley. (Presented by the author.)

The Possible Existence of Deep-seated Oil Deposits on the Gulf Coast. By A. F. Lucas. (Presented by title.)

Lithology of the Berea Sand in Southern Ohio, and Its Effect on Production. By L. S. Panyity. (Presented by title.)

THE JAMES DOUGLAS MEMORIAL SERVICE

On Tuesday afternoon, Sept. 3, the Institute held a service in commemoration of Dr. James Douglas, who died at New York on June 25, 1918. President Sidney Jennings presided.

PRESIDENT JENNINGS.—We are met here to show our appreciation of the life of a great man, and we shall gain strength to do our own daily tasks from the contemplation of a career strongly founded, continuously built up, having the star of hope as its guiding light.

Dr. Douglas was an engineer, a scientist, a literateur with a charming sense of style, a benefactor with a singularly wide variety of interests, and a man who had acquired wisdom and understanding, which surpass very great riches. As the poet puts it, "When some beloved voice that was to you both sound and sweetness faileth suddenly, and silence against which you dare not cry aches around you like some disease both strong and new, we poor mortals strive to fill that silence with words of sympathy and appreciation." The very limitation of these words shows our need of the light and guidance which we can acquire from the contemplation of the life of Dr. Douglas.

Other speakers will deal with various phases of the life of Dr. Douglas; I can speak from personal knowledge of only one of his many benefactions to the American Institute of Mining Engineers.

In 1905, Mr. Andrew Carnegie gave to the four national engineering societies of America a sum of money sufficient to erect a large and beautiful building in which to house their activities. He wisely coupled with that gift a proviso that the societies should acquire the title to the ground upon which it was to be built. That entailed upon the slender resources of the American Institute of Mining Engineers a very heavy burden. Many attempts were made to lighten it and contributions were made, but still the burden was heavy, and when I was elected to the Board of Directors, it still weighed heavily upon us.

Dr. Douglas, although he had twice filled the office of President of the Institute and had given much of his time and thought as a Director, came to the rescue and undertook to raise the large sum of money that was necessary to free the Institute from debt. In a comparatively short time, in 1914, largely through his own personal contributions and those of members of the firm with which he was associated, this burden was lifted, and the Board of Directors and members of the Institute were able to breathe once more the air of financial freedom.

In addition to the numerous and large gifts that Dr. Douglas has made to the Institute, by the terms of his will the sum of $100,000 has been given it for the use of its library, and it is hoped that this sum, together with the yearly contributions made by the four national societies, will bring the library service to that degree of perfection which all those who are interested in the library and its work aim to achieve.

I shall now ask Mr. E. P. Matthewson, a Canadian, to tell us of the early days of Dr. Douglas, who was also a Canadian.

E. P. MATTHEWSON.—In my early youth I knew of no name in science to compare with that of Dr. Douglas. He was associated many years with the late Dr. T. Sterry Hunt, and Dr. Hunt was the immediate cause of my coming to the United States from Canada and entering on my professional career in this country.

Dr. Douglas was a man of most benevolent disposition, far-seeing in many ways, who, though possessed of much wealth, thought nothing of money; he had not the love of money at all. The only use he had for money was to do good to those who needed it.

Dr. Douglas was particularly thoughtful of his Canadian fellow countrymen and particularly of those who were engaged in scientific pursuits. The educational institutions of Canada were frequently benefited by his benevolence. McGill University was highly favored by Dr. Douglas, after he learned of the financial difficulties of that institution. McGill, not being granted any aid from the state, and relying upon private benevolence, had outstripped its income in giving what it could of educational advantages to Canadians, and it became necessary at one time to have a campaign for more funds. In this campaign Dr. Douglas responded nobly and was the means of getting the necessary funds to go on with the good work of that University. The University from which he graduated, Queens University, was also frequently aided by his benefactions. Altogether, the sums given by him during his lifetime to Canadian institutions would be probably up in the millions, but he was so unobtrusive and so retiring in his disposition that he seldom allowed his name to be used in connection with these matters unless it was possible, by using his name, to influence others to similar benevolence. Anywhere in Canada, if you mention the name "Douglas," you will find people who will say at once, "That was a great Canadian, a man we all reverenced."

(Mr. Matthewson next read the biography of Dr. Douglas printed in the July 6, 1918, issue of the *Engineering and Mining Journal*. As a biography written by Dr. R. W. Raymond has also been published in our *Bulletin* No. 141, and an "Appreciation," by Dr A. R. Ledoux, in our *Bulletin* No. 109, it is hardly necessary to reprint here the account read by Mr. Matthewson.—ED.)

Dr. Douglas had the broadmindedness to introduce the open door into metallurgy. Prior to his advent into the metallurgical field, the non-ferrous metallurgists in this country, in Canada, and practically all over the world, were absolutely oyster-like toward visitors. No one was admitted who did not have a letter of recommendation from one of the Board of Directors, at least. But Dr. Douglas, early in his career in this country, allowed every one to come to the plant and visit the mines with which he was connected. He welcomed them, and argued that he was getting as much benefit from the visitors as the visitors were getting from him.

The example of Dr. Douglas was followed by many metallurgists in this country, and today we may say that there is hardly a non-ferrous metallurgical establishment in the United States and Canada to which a person who is honestly seeking information cannot obtain access. Of course, during war times a few precautions are taken for fear that information might get to the enemy. This, of itself, is enough to make Dr.

Douglas called a great man, and to let his name go down to posterity as really the father of open-door metallurgy.

PRESIDENT JENNINGS.—I will ask Mr. W. R. Ingalls, Editor of the *Engineering and Mining Journal*, who was thrown in contact with many of Dr. Douglas's scientific activities in the United States, to tell us of his achievements as a scientist.

W. R. INGALLS.—In the death of Dr. Douglas the Institute lost its greatest member, the mining industry lost one of its greatest exponents, and the world lost a philosopher. Fortunate are we all that his works and his inspiration live after him. The results of his material work will doubtless disappear in the course of time, just as did most of the construction work of the Greeks and the Romans, but just as the teachings of their philosophers survive, so will those of Dr. Douglas, and his inspiration will be one of the world's greatest possessions forever.

The appreciation of how great a man he was will be clearer and keener in the future than it is now. No matter how much we may think we understood him, reflection and meditation will surely reveal to us many things about him that not yet do we see.

Dr. Douglas was a very successful man in material things, and it is one of the remarkable features of his career that this kind of success did not begin to accrue until he was nearly 50 years of age. It is even more marvelous to us in his profession that, although he attained a great age, his great accomplishments were achieved during about 33 years, and those the latter years of his life.

He became a captain of industry, which in itself was a distinction for one who was inherently a philosopher, and he acquired great wealth for which he did not care and which he bestowed bounteously upon many worthy causes; but ambition for material power and a sordid interest in acquiring a great fortune were the furthest of anything from his thoughts. His mind and his fibre were different; his habits were simple; his mode of living was most modest. His thoughts were largely of his studies, and those studies were mainly concentrated upon the improvement of human welfare.

I do not remember when I first became acquainted with Dr. Douglas. I knew of him, of course, from my introduction into professional studies. The beautiful metallurgical process devised by him in connection with the redoubtable Sterry Hunt was one of the things that we were given to ponder upon in the class-room.

I think I first met Dr. Douglas about 20 years ago in connection with his very ingenious muffle roasting furnace, but my intimate association with him was during the last 12 years, when there existed the relations which naturally exist between an editor and his most valued contributor, and also the relations that exist between the fellow members of committees engaged in doing public work.

It has not been until his death that I appreciated the demands that I made upon him and the generosity and the alacrity with which he invariably acceded to them. That is simply one of the revelations of the character of this remarkable man that come to us when he is no longer with us.

Considering his multifarious engagements as the head of the great mining, railway, and other industrial enterprises, I am appalled to think that I could ask him, in the interest of the profession and of the public,

to put his work aside and do the writing and the speaking that I and others wanted him to do. For the very reason that he wanted to aid his fellow men, he was so generous. Oftentimes he would suggest to me editorials that should be written and should be published. Many of the most important editorial expressions that we have made to the public during the last 12 years have been the anonymous contributions of Dr. Douglas, besides those to which he so liberally affixed his name. Oftentimes he would say to me that at the metallurgical works of the Copper Queen Company some important investigations were coming to a head, investigations whereof the profession should be fully informed, and that he would direct his metallurgical men to work up papers on those subjects for the benefit of the industries.

Now, to my mind, the thing that above everything else constitutes Dr. Douglas as one of our great men, a man greater than any of us yet appreciate, is just that interest of his in the promotion of human knowledge and the promotion of such knowledge as would better the welfare of the human race and enable men to work more advantageously.

I think perhaps his first declaration of the principle of the open door, of which Mr. Matthewson has spoken so fittingly, is to be found in his presidential address to this body in 1899, and may I read just a few words from that address,[1] which give the essence of his ideas?

> The motives influencing the great body of writers who, without any pay, use the technical journals and such media of communication as our *Transactions*, in order to give to the brethren of their craft the results of their dearly earned experience are various and complicated, but in the majority of cases the impulse originates in the desire for reciprocity and in the hope that others will tell what they know in return for what we ourselves communicate and that, therefore, we shall learn at least as much as we can teach.

Dr. Douglas himself practised what he preached. There was never any secret about operations at the Copper Queen or at any of his enterprises. To every visitor and applicant for information the helping hand was extended. This spirit spread among other managers, and to that spirit more than anything else ought we attribute the high stage of efficiency to which our American mining and metallurgical industries have come.

If we should turn to the other side of the shield, we should find that in Great Britain these industries have been backward for just the opposite reason. A few years ago I asked a distinguished lead smelter of Great Britain to contribute a paper upon the lead smelting industry of his country. He replied that he could better contribute a paper upon the lead smelting industry of America, for, although he had been engaged in a prominent metallurgical center of Great Britain for 30 years in one of the leading smelting works, and although in the same place there were two other smelting works like his own, he had never, during the 30 years, been into either of them, nor had either of those managers been into his works; but since this great war has been in progress, our British friends have learned the lesson that Dr. Douglas first taught in this country. They are profiting by it, they are collaborating, they are throwing open their doors to one another for an exchange of information to such an extent that they are perhaps outdoing us, and will not unlikely compel us to look to our laurels.

---

[1] *Trans.* (1899), **29**, 648.

And so it is that the spirit of Dr. Douglas is spreading all over the world, not only through our own country and Canada, but also through Australia and Great Britain, as it will also spread through other parts of the world, and it is for that reason that the time is going to come when the entire world will know him for the great philosopher and the great prophet that we already know him to be.

PRESIDENT JENNINGS.—I will now ask Mr. T. H. O'Brien, who has been delegated by the Phelps, Dodge Corporation, as one who was intimately acquainted with the activities of Dr. Douglas, to tell us of his work in Arizona and the Southwest, and in America generally.

T. H. O'BRIEN.—The death of Dr. Douglas closed a long, honorable, and eventful career, filled with accomplishments that would have occupied fully the lives of several men of less marked ability. Seldom has one man combined in the short span of human life such exceptional achievements. Little can be said regarding his knowledge and ability as an engineer and a scientist that has not already been published, and is known to the members of this Institute. His accomplishments were so varied and extensive that nothing short of the story of his life, written by a competent biographer, can do him justice.

I am not here to give a detailed account of his business career, but rather as a friend and an employe who was associated with him for many years, to tell you something about his work in connection with the company of which he was so long the executive head, and to pay him tribute.

It was in 1880, attracted by some specimens of ore sent from a mine in Arizona, that he paid his first visit to that far off land of which the East then knew so little, which had only lately been made accessible by the construction of a trans-continental railway. It was then that he became associated in a business way with the great Southwest, and this provided the opportunity for his exceptional talents in the development of the mining and railroad possibilities of that part of our country and of Northern Mexico. He never lost the interest thus acquired, and became truly western in his views and preferences.

The Copper Queen mining property at Bisbee had lately been opened, and this attracted him. He interested the late William E. Dodge and D. Willis James, who were at that time metal merchants of New York and partners in the firm of Phelps, Dodge & Co. They began systematic development work. After less than four years the ore began to fail and dark days set in for the enterprise. These reverses only stimulated him to greater effort, and he persisted in his belief that further development would culminate in permanent success. The world knows today how well founded were his perseverance and faith in what has now become one of the greatest copper properties in the world, and it is not too much to say that he alone was the moving cause of that success. It is significant, too, that this achievement came to him when he was nearly fifty years of age, at a time when most men have lost the eager faith and assurance of youth. But this determination was characteristic of the man so long as bodily strength was given to him to follow the direction of his ever versatile and orderly mind.

Perhaps the fact that he entered the mining profession at this time in his life accounts for his having been able to avoid the small prejudices prevalent in the early days of mining and smelting. His was a larger viewpoint, and everything was looked at and considered in a bigger, broader way. His ability to see ahead enabled him to make

provision that insured the steady growth of his operations, and it was this gift of broad vision, combined with the conservative judgment of the original members of Phelps, Dodge & Co., that accounts for the steady growth of the enterprise. He was a dreamer of dreams; he saw possibilities where others saw none; but he lived to see his dreams come true.

He and his associates extended their operations to a consolidation with the Atlanta Company, and later to the districts of Morenci and Globe, in Arizona, Nacozari in Mexico, and afterward to Tyrone in New Mexico. The satisfactory development of these mining and smelting operations under Dr. Douglas' guiding hand soon led him to acquire for the company the coal mines and coking plant at Dawson, New Mexico.

The growth of these numerous enterprises emphasized the urgent need for better transportation facilities. The ability of their founder was equal to the necessity, and Dr. Douglas now turned his attention to the construction of the El Paso & Southwestern Railway system, connecting the various mining and smelting plants with the newly acquired coal property. He thus became a builder of railroads and a master of transportation as successful as he had been in exploiting the mining industry of the Southwest.

What the magnitude of these operations has meant to the Southwest, and especially now, during the great world war, can only be appreciated by those who know the extent of the aid they are giving to the country and its allies in providing raw materials so necessary to the successful carrying on of the war. Truly it may be said that this man did not lay down his cares until he had fully done his part toward winning the great war for permanent peace and equal rights for humanity.

During the development of the different Phelps-Dodge mines, mills, and smelters, there was no man in America, or perhaps in the world, who did more than Dr. Douglas to break down the secrecy as to methods that was prevalent years ago in the great industrial enterprises. He believed in frank, reciprocal relations between competitors in business, and in the greater efficiency that would grow from this policy. Those in charge of his industrial plants were instructed to give every facility to those who earnestly sought to learn. His views on this subject were fully justified, and it became a matter of common knowledge in the business world that his enterprises occupied a unique and enviable position among like institutions. We can only conjecture what great influence this sound policy had in the economic development of the country and the world.

His sympathetic, kindly and democratic nature toward all classes of his employes, and toward those with whom he came in contact, endeared him to each and every one, and to them he was a close personal friend who always had their interests at heart. He was lovingly called "The Professor" by the older prospectors and miners, and was a familiar figure in all southwestern mining camps in the early days.

His philanthropies were many, broad, and effective. In this he avoided publicity, and it will never be known to what extent he aided his fellow man. Individuals alone were not his only charity, but he also went to the assistance of many educational institutions and scientific bodies. He ever stood ready to give counsel, and many a rough place he made smooth for a younger or less fortunate fellow.

He was perhaps the most conversant man on a wide number of subjects as one could ever hope to meet—equally at ease with any subject, unusually well informed on all.

He was always ready to recognize and reward merit, and cared nothing for mere place or position. He was splendidly thoughtful of those who worked with him in his great enterprises, from the highest to the lowest, for their comfort and well being, and no one enjoyed greater loyalty and respect from his associates and employes.

It has seldom been given to one man to see the well ordered success of his life work so completely realized, leaving it, as he did, with the knowledge that he had earned and received the genuine love and respect of all who knew him.

To us who worked with him, his life is now a splendid memory which we will carry with us as an inspiration to the end of our days.

IN MEMORIAM

It is probably safe to estimate that at least one hundred members of the Institute have already given their lives to the United States and its Allies in the present war, but the following notes include all those of whose deaths we have definite information.

LEWIS NEWTON BAILEY

Lewis Newton Bailey, Master Engineer in the 4th Regiment, U. S. Engineers, died of pneumonia at Camp Merritt, N. J., on April 30, 1918. An account of his professional work, prepared by Stanly A. Easton, his former employer at Kellogg, Idaho, was published in *Bulletin* No. 140, August, 1918.

LEWIS NEWTON BAILEY.

LIEUTENANT LOUIS BAIRD

Louis Baird, a Lieutenant in the Royal Field Artillery of the British Army, died on the battlefield in 1915.

Lieutenant Baird was born July 28, 1880, at Stirling, Scotland. His technical education was obtained at King's College, Melbourne, Australia, in 1893 to 1895, and at the Technical College at Glasgow, Scotland, in 1897 to 1900. After an apprenticeship with the Mexican J. & S. Rec. Co. of Mexico, lasting from 1900 to 1903, he became mill superintendent for the Cia. Minera Benito, at Juarez, Zac. During the year 1905–6 he was assistant manager of the Candelaria y Anexas, at Pinos, Zac., and from 1906 to 1907 was engineer with the Cia. Minera Jalisco, San Sebastian, Jalisco.

At the time of his admission to the Institute, in 1908, he was practising as a mining engineer at Etzatlan, Jalisco, Mexico. For the next four years he practised his profession in the City of Guadalajara, Jalisco, removing, in 1913, to Ixtlan del Rio, in the State of Tepic. It was from here that he returned to England to put his services at the disposal of the British Government. The Institute is not definitely informed as to how, where, or when Lieutenant Baird met his death.

WILLIAM MORLEY COBELDICK

William Morley Cobeldick, one of the British Royal Engineers, died from gas poisoning on Oct. 7, 1915.

Mr. Cobeldick was born March 21, 1882, in London, England, where his early education was obtained at the Finsbury Technical College. In 1898 he was employed by the British Columbia Exploring Syndicate as electrical engineer with their gold dredging plant on the Fraser River, British Columbia, his principal work being the erection and operation of the power plant, to which were added certain assaying and metallurgical duties. The Government of British Columbia awarded him a diploma for efficiency in work of this character.

In 1901 he became works manager and chemist to the Metal Trust, Ltd., of London, and for four years was instrumental in developing the Swinbourne-Ashcrofts chlorine process for treating lead-zinc sulphides. The years 1905 to 1907 he spent at the Royal School of Mines, London, at the conclusion of which he was awarded the Bessemer Medal and prize in the Department of Metallurgy. The next six months he spent in inspecting metallurgical plants in Great Britain and Europe.

Beginning in 1907, he spent the next two years in the development of a process for treating tin-copper sulphides from the Oonah Mines, Ltd., of Tasmania, which involved the erection and operation of an experimental reverberatory plant and leaching appliances for the treatment of this ore at Swansea; in this work he was associated with Messrs. A. Hill and Stewart of London. The first part of 1910, he spent in making a special study of the treatment of copper-tin mattes and alloys and was then appointed chemist to the Wallaroo & Moonta Mining & Smelting Co., at Wallaroo, South Australia, which position he occupied at the time of his admission to the Institute, in 1913. The following year he returned to England and at once entered upon his military service.

RALPH DOUGALL

Ralph Dougall enlisted as a private in the Fourth University Company of the Princess Patricia Regiment, declining the solicitation of his friends that he should apply for a commission. He was killed in action early in the war and only shortly after having become a member of the Institute.

RALPH DOUGALL.

He was born at Montreal, Canada, in 1875. His earliest education was received in Montreal but was continued from 1885 to 1892 at schools and academies in Brooklyn, Whitestone, and Flushing, L. I. For his technical education he returned to McGill University, where he graduated in 1897.

His first professional occupation was as transitman engaged in the running of township lines in the Rainy River District of Ontario. In 1899, he was made assistant chemist at the Guggenheim smelter at Aguascalientes, Mexico. From 1900 to 1903, he was chief chemist for La Compañia Minera de Peñoles, at Mapimi, Durango. We have no information as to his pursuits during the next eight years, but from 1911 until 1914, when he became a member of the Institute, he was chief engineer for the Bankhead mines in Alberta, Canada.

LIEUTENANT-COLONEL ALFRED WINTER EVANS

Lieutenant-Colonel Evans, who was in command of the Third Battalion of the New Zealand Rifle Brigade, and had been cited in Distinguished Service Orders and received the Distinguished Conduct Medal, was killed in action on Oct. 12, 1917.

Alfred Winter Evans was born in Natal, South Africa, in 1881, and received his preliminary education in the Durban High School. For the next five years he attended St. George's School at Harpenden Heights, England, until 1898. Returning to South Africa, he worked for three months of 1898 as underground sampler for the Crown Deep Gold Mining Co., at Johannesburg, and for six months of the following year he was shift-boss for the Crown Deep, Ltd. At the outbreak of the Boer War he took an active part and was engaged on military service from 1899 to 1902. At the close of the war, he came to New York and attended the Columbia School of Mines, where he graduated with the degree of E. M. in 1906. A part of that year he spent as assayer to a mining company at Poland, Arizona.

In 1907, he returned to South Africa and engaged as underground

contractor in charge of mining and development at a number of the South African mines, notably the French-Rand, the Village Main Reef, the City Deep, and others. In 1908, he acted as shift-boss for the Ferrerra Gold Mining Co. at Johannesburg. In 1909, he was appointed acting general manager for the Consolidated Goldfields of New Zealand, but, returning to South Africa, for the next two years he was assistant general manager of the Simmer Deep Gold Mining Co., at Johannesburg. In June, 1911, he returned to New Zealand as general manager and consulting engineer for the Consolidated Goldfields of New Zealand, at Reefton, which position he held at the time of his admission to the Institute in 1914. Early in September, 1915, he left New Zealand for active service in France.

LIEUTENANT THOMAS CLARENCE GORMAN

Thomas C. Gorman, a lieutenant in the Second Tunnelling Company of the Canadian Engineers, was killed in France on March 18, 1918. He was resting in his sleeping hut and was in the act of writing a letter when a bursting shell killed him.

Lieutenant Gorman was born in Ottawa, Canada, in 1888, and after preliminary education at Ottawa University and the Ottawa Collegiate Institute, he graduated from McGill University in 1912, as a mining engineer. The year 1909 was occupied at one of the Canadian graphite mines, and the summer of 1911 he spent with the Granby Mining, Smelting & Power Co., Ltd. At the time of his admission to the Institute, in 1914, he was sampler with the Dome mines at South Porcupine, Ontario. His next engagement was at the Creighton mine, Ontario, but in 1916 he joined the Canadian Expeditionary Force and went to England. The Institute has not yet been able to get into communication with Mr. Gorman's parents in order to secure more detailed information and a photograph.

LIEUTENANT WILLIAM HAGUE

William Hague, 1st Lieutenant Co. F, 116th Regiment of Engineers, and a member of the Institute since 1906, died of pneumonia in France, on Jan. 1, 1918.

Lieutenant Hague was born in Orange, N. J., March 31, 1882, the son of the late James D. Hague, a distinguished mining engineer and a life member of the Institute, and Mary Ward (Foote) Hague, of Guilford, Conn. He attended Milton Academy, Milton, Mass., and was graduated from Harvard in the class of 1904. He was a nephew of the late Arnold Hague, of the United States Geological Survey. Seven years ago he married Elizabeth Stone, of Milton, who with their son, James D. Hague, six years old, survives him.

Lieutenant Hague's mining career began immediately after his graduation from Harvard, when he went to Bisbee, Ariz., to be a surveyor's helper in the mines of the Copper Queen Consolidated Mining Co. In 1905, he became an instrument man, being engaged on the construction work of the Copper Queen smelting plant at Douglas, Ariz. In the latter part of the same year he was transferred to the geological department of the company, being occupied in that work until May, 1906. The summer of 1906 was spent in prospecting in Michigan; but in the autumn he returned to Arizona as assistant in construction of the Copper Queen

plant at Douglas, and remained on that work until October, 1907. The autumn and winter of 1907–08 he spent in traveling in the United States and Mexico, his purpose being to broaden his experience; wherefore he proceeded leisurely, occasionally taking a position for a short time. Thus, for two months he was employed as a shift boss in the cyanide plant of the Guanajuato Consolidated and Milling Company.

A serious illness that befell him in 1908 kept him from work during the major part of that year, but upon his recovery, in December, he was appointed managing director of the North Star Mines Co., a famous and successful gold-mining enterprise in California, with which his distinguished father had been identified for a great many years.

LIEUTENANT WILLIAM HAGUE.

However, William Hague could not keep away from purely professional activities in directions wherein he was intensely interested, and during a considerable part of 1909 and 1910 he was engaged in geological work at Bisbee, Ariz., for the Copper Queen Consolidated Mining Co., making occasional trips to Grass Valley, Cal.

From June, 1910, up to the time when he entered the United States Army, Mr. Hague resided at Grass Valley as managing director of the North Star Mines Co.; but during 1911 he joined J. R. Finlay as assistant in the appraisal of copper mines for the State of Michigan.

Lieutenant Hague attended the Officers' Training Camp at Plattsburg in September, 1916. After receiving his commission, he was called to the Engineers' Training Camp at Vancouver Barracks, Oregon, last spring. Later he was transferred to the camp at American Lakes, near Tacoma, and from there to Charlotteville, N. C. He was ordered with his regiment to Mineola last November, and soon afterward left for France. His family received news of his safe arrival abroad Dec. 15 last. Since then a cable of Christmas greetings to his family was the only word received from him.

In the *New York Evening Post* a few days after news of his death had been received, there was a tribute from an anonymous friend which may well be repeated:

A few short weeks ago there was the bustle of camps; then a great silent flitting of our boys going "over there," and now there are commencing the first brief lists of those who are to lie in the torn fields of France. Today we read of Lieut. William Hague, whom we said good-by to hardly more than a month ago—so clean, so young, so strong—who, abandoning the professional career in which he had won such com-

mendation and which held for him such promise, leaving his wife and his little boy to whom he was so dear, answered at once the call for men of his training, and is now dead "in the service of his country."

There are many friends of that courtly and dignified gentleman James D. Hague who recall, both here and in Stockbridge, the parental pride in the promising lad of such a little time ago—the eager schoolboy at Milton, the rather grave youth at Harvard, his entry into new experiences in the Western mining world, and who, seeing him during his stay at Camp Upton, realized that the old Puritan stock was still sound and true—and now with him the struggle is over and the sacrifice made.

CAPTAIN WILLIAM TEASDALE HALL

Captain Hall, who was admitted to Junior Membership in the Institute in 1915, while still a student of mining at the University of Toronto, was killed in action in France on May 19, 1917.

Captain Hall was born in Toronto in 1893, and received his academic training at Harbord College, from 1908 to 1911, when he entered the University of Toronto, School of Practical Science. During the three summer vacations of his university course, he was employed by the O'Brien mine at Gowganda, next by the McIntyre Mining Co., at Porcupine, and finally by the Mines Branch of the Geological Survey, which was conducting magnetic surveys to the north of Port Arthur.

When war was first declared, Mr. Hall endeavored to join the artillery as an officer, and for the purpose secured a provisional lieutenancy with a Hamilton battery, but he did not receive an overseas appointment, and on being graduated as a mining engineer in 1915, he was offered a position in Chile, which he accepted. He left Toronto on May 27, 1915, and was engaged in Chile as a mining engineer for nearly a year. In the latter part of April, 1916, he decided to offer himself again for service at the front. He crossed the Andes and sailed for Liverpool, where he landed on May 13, 1916.

CAPTAIN WILLIAM T. HALL.

On May 27, 1916, Captain Hall was given a commission as a lieutenant in the Royal Flying Corps, 21st Squadron. He went to the front on Sept. 1, 1916, and remained there continuously. His record with the Royal Flying Corps was considered a remarkable one, for he was at the front within two months of the date on which he was granted a commission, during which interval he took the prescribed technical course at Oxford, and aviation training at Netheravon and Bristol.

On Sept. 14, 1916, he took his first flight over the German lines, when his engine stalled and he had to volplane down, fortunately landing on the French side of the lines. On Sept. 16, he went over the lines with six others, and not returning immediately with the others, was lost. He tried to make for the sea and come back following the course of a river, but when he did descend he found that he was 60 miles west of Paris and 100 miles south of his lines. He flew over to Paris and stayed there for the night, going back to his squadron the next morning. Then on Oct. 4, he was sent up at night for the first time, and in making a landing he passed the flares just as he struck the ground, which put him in total darkness. He struck something and his machine turned a complete somersault, which accident put him in the hospital for ten days.

In December, 1916, he left the 21st Squadron and was transferred to the 24th, as the 21st was made an Artillery Squadron and he preferred to remain a fighting scout. In the same month, he was made Acting Flight Commander for about 6 weeks, and about April 3, 1917, his rank of Flight Commander was confirmed. The beginning of May he started to introduce a number of new machines for his squadron, these being of an entirely new type. On May 19, he was up with one of the machines in the evening, practising sharp turns and dives, when the wings suddenly crumpled up and he fell 700 ft., being killed instantly. He was buried in a French Cemetry at Monchy Lagache about 8 miles southeast of Perronne, and about 25 miles east of Amiens.

LIEUTENANT BERNHARDT EDWARD HEINE

Bernhardt Edward Heine, a lieutenant in the Aviation Service of the U. S. Army, died as the result of a fall in an aeroplane at Fort Sill, Okla., on Aug. 10, 1918. The accident occurred on Aug. 2, when the machine in which he was flying with Lieutenant Carsons fell from a height of 1500 ft.; Lieutenant Carsons was instantly killed, but Lieutenant Heine died from his injuries a week later.

LIEUTENANT BERNHARDT E. HEINE.

Lieutenant Heine was born at Mount Clemens, Mich., in 1895. After attending the local High School he entered the Michigan College of Mines, and became a Junior Member of the Institute while still a student. He graduated in 1916, with the degree of B. S.

In 1914 he served as a transitman for the engineering department of the City of Hancock, Mich.

Lieutenant Heine had been in the army since 1916, having been with the troops at the Mexican border. He had been in the Aviation Section since August, 1917.

CAPTAIN JOHN DUER IRVING

John Duer Irving, Captain in the 11th Regiment of Engineers, and formerly Professor of Economic Geology at the Sheffield Scientific School, died of pneumonia in France, on July 26, 1918. An account of his life, and an appreciation of his personality, written by Prof. James F. Kemp, with whom Captain Irving was on terms of intimate friendship for many years, was published in *Bulletin* No. 141, September, 1918.

A copy of the following letter written by Major Evarts Tracy to President Hadley, of Yale University, has been handed us for publication through the courtesy of Mr. B. B. Lawrence.

July 27, 1918.

Dear President Hadley:

Before this reaches you, you may have heard of the death of Captain Irving, which occurred last night.

I only wish to tell you what a loss it has been to the Army. It is always sad to have anyone die here otherwise than in action. In the latter event one always feels that it is a proper and glorious death.

Captain Irving died as gloriously as any man in the service ever died. He gave all he had. The amount of work he accomplished here in the design and adoption of his methods in mining and shelter dugouts, which are the only life savers when batteries are registered by the enemy, was beyond calculation.

He worked himself to death, and in the face of opposition proved that he was right, time after time. We all remonstrated with him at his hours, but his devotion to duty, as he conceived it, lowered his vitality, and pneumonia, following a bad attack of the so-called Spanish grippe, cut him down.

When I tell you that since he was taken ill, the personnel department has been over the records of over fifty men, trying to find someone to take his place, without success, you can appreciate his value to the service.

If you can let any of his friends know what we, his close associates here feel, about his loss we will appreciate it. No one here has done more for the United States than he has.

LIEUTENANT EDWARD HALE PERRY

At the height of the first great German offensive of the Spring of 1918, Edward Hale Perry, of Boston, First Lieutenant, Company D, Sixth Regiment Engineers, U. S. Army, was killed on March 30, near Warfusee—Abancourt, Picardy, France, while defending the Bois des Tailloux against the terrific plunge aimed at Amiens.

Lieutenant Perry was born in Boston, Jan. 23, 1887, the son of Georgianna W. and the late Charles F. Perry. After completion of his college preparatory course, he travelled for a year in South America and Europe before entering Harvard with the class of 1910. It might have been regarded as the natural thing for Perry, upon graduation, to choose a path that would lead to a business or professional career at home, but there were in his character a solidity, a horror of sham, a contempt for the "soft" things, and a love of the open which caused him to be attracted to a life of stern and sturdy reality. Accordingly, he entered the graduate mining school at Harvard, and received the degree of Mining Engineer in 1913. In the meantime, two summers spent in Western mining camps had attracted him particularly toward the geological aspects of mining so that the latter part of his course was directed definitely toward mining geology.

Because of his evident aptitude for geological problems, his mental and moral integrity, and his boundless enthusiasm, Perry was asked upon his graduation from the mining school to join the staff of the

Secondary Enrichment Investigation. This he did, giving his services without compensation, though relinquishing in consequence an attractive opening in the geological department of one of the large mining companies of the Southwest. For two years he was thus engaged in intensive geological study of the principal copper mines of the country. During this period, his scientific development and his growth in judgment and poise made a profound impression on those most closely associated with him. And the value of his efforts and his spirit in the work of the organization is beyond measure or recompense.

At the conclusion of the field work of this investigation in 1915, Perry joined Dr. Augustus Locke, who had been associated in the same research, and took up professional practice in mining geology. In this Perry met with instant and conspicuous success, winning as much by his personal force, his ready grasp of every phase of a situation, and his ability to bring men to his point of view, as by his conscientious study and keen understanding of the conditions of ore occurrence and his sanity in interpretation and recommendation.

LIEUTENANT EDWARD HALE PERRY.

Notwithstanding his unusual success in commercial work, Perry maintained with keen relish and devotion, his interest in the scientific aspects of geology. With Dr. Locke, he contributed a paper[1] on "The Interpretation of Assay Curves for Drill Holes." He sacrificed time and income in order to spend two or three months each year in continuing his special research upon the relations of rock alteration to ore deposition. His last days at home, even to his last hour before going to Plattsburg, were spent completing in outline the record of four years of study upon this subject, which Dr. Locke and the writer of this inadequate tribute to his memory will enjoy putting into final shape for publication, and which is certain to prove a noteworthy and valuable contribution to the science.

While Perry was in the midst of a professional engagement in Arizona, our country entered into the European War. He immediately advised his closest associates of his intention to enlist, and as soon as he could, with added help, complete the work then in hand, he came East and entered the officers' training school at Plattsburg, in May, 1917. In June, because of his technical training and experience, but particularly because of his application and ability, he was transferred to the Engineer Officers'

[1] *Trans.* (1916), **54**, 93.

Camp at Washington, and soon thereafter was commissioned First Lieutenant in the 6th Regiment Engineers, as reserve officer in charge of mining, sapping, and demolition.

Perry's work of instruction with his men won quick recognition and commendation. He was offered positions as instructor in this country, carrying with them higher rank than he could hope to reach in the regular army, but believing that his duty lay at the Front, he declined to consider them. He sailed for Europe in December, 1917. In January, Companies D and B were detached from the rest of the Regiment and, because of the ability of their officers, were brigaded with the 5th British Army and sent to Peronne to build heavy steel bridges over the Somme. While this work was going on, the Germans launched their great drive on March 21. For the ensuing few days it was the duty of the Engineers to stand by their bridges until the retiring British Army had crossed, and then demolish them. This they did, Perry and his platoon being the last to leave after the British Artillery had all passed. Then, on the 27th, these two companies joined that motley but determined and immortal band which General Carey, realizing the imminence of disaster to the entire Allied forces due to the crumbling and withdrawal of part of the British line, picked up and threw in to close the fast-widening breach. Lieutenant Perry had command of a section of the front line trench between Hamel and Villers-Bretonneux near the middle of this gap.

The energy and devotion which Perry put into his work as a soldier, and the spirit and fine courage with which he faced and paid the Great Price, may best be revealed by extracts from letters written to relatives by his associate officers since his death.

His fellow-Lieutenant of Company B wrote:

I have never worked with a man who put as much spirit and energy into his work, and who inspired men under him, causing them to exert their best efforts to help a common cause.

The officers and men who were privileged to know Edward feel that they have lost a true friend, and the men under him knew they possessed a leader of remarkable qualities, one who knew their wants and who cared for them before thinking about himself and his own comforts.

Perry's Captain said in part:

During the previous months he was a tireless worker, never satisfied unless he was doing his own job and most of his neighbors. In the early part of March, when we were on heavy bridging operations, he used to leave camp at 5 a. m. and return at 8 p. m. while two shifts of men worked under him; then he would spend a good part of the night on plans and lists of material.

No officer in the regiment was so trusted and looked up to by the men; they gave him their money to keep for them, asked his advice on all sorts of affairs, and besieged me with requests to transfer to his platoon. In his ability to get work done by leading instead of driving, he had no equal. And as a friend and brother officer, he leaves an unfillable gap that is brought to our attention every day. He had been recommended for promotion not long before his death.

He died as he had lived, helping others. It was Saturday, March 30. We underwent a good preliminary bombardment followed by the infantry attacks, supported by heavy barrages. Our trenches were pretty poor, as we had to get underground at the same time that we were keeping Fritz out of the way, and the artillery smashed a good deal of our defenses. A shell had demolished a traverse in Perry's section of trench, killing four men. He was working in the gap repairing the damage with his own hands, when a bullet, probably from a machine gun in an enemy aeroplane which was raking the trenches, penetrated his skull.

We all feel that his place in this organization, which he helped to build up, will never really be filled, but we draw what satisfaction we can from the circumstances of his death; as we must all go sometime, I know of no straighter, cleaner way than his.

Colonel J. M. Hodges, his regimental commander, has written:

At a critical time during the German offensive in March, this organization was given a section of the front-line trench which was essential to the scheme of defense, and orders had been received that it was to be held at all costs. Lieutenant Perry was commanding a platoon of his company in the front line. He was killed instantly by a bullet through the forehead. At the time of his death, he was engaged in reconsolidating a section of trench that had been demolished by a previous bombardment and in arranging for the burial of his men who had been killed.

Lieutenant Perry was an excellent soldier and an exemplary officer. I had always considered him as one of the best, if not the best, of the young officers of the Regiment. He had real ability and could be counted on for results. At the critical time he did not weaken; I saw him shortly before he was killed; his conduct under fire was splendid and an inspiration to his men. His loss is felt deeply by all ranks. Thanks to him and to others, who like him, paid the full measure of devotion to their country, our line was held until the critical situation in that vicinity was at an end. He died the true death of a soldier, with his face to the enemy.

As we now look back, it is easy to believe that this holding of the line of defense intact by General Carey and his men was a determining factor in the outcome of the war. To have played so important and noble a part in this vital effort as that taken by Perry is assuredly the privilege of few. Our lives, it seems, are like capital entrusted to us to be expended as wisely and effectively as we may. With them we purchase whatever of accomplishment the stuff that is in us permits. It is impossible to escape profound regret that a career so full of the highest promise, and a personality so overflowing with all that is fine and lovable, should have been cut short at the age of thirty-one. Yet who can doubt that in a few months Perry bought with his life the fullest achievement of a life-time—a glorious part in the salvation of Liberty and Justice and Decency, indeed of Civilization itself! L. C. GRATON.

LIEUTENANT FRANK REMINGTON PRETYMAN

Frank Remington Pretyman, 2d Lieutenant with the Royal Engineers, was killed in action on June 17, 1916.

Lieutenant Pretyman was born at Chicago, Ill., in 1890. He received his academic education at Marlborough College, Wiltshire, England, and in 1908 entered the Royal School of Mines, London, where he remained for two years. From 1910 to 1911, he was engaged as mine surveyor for the Mazapil Copper Co. in Zacatecas, Mexico, and for the next year with the Foundation Co. of New York, which was engaged in sinking a concrete drop-shaft at St. Albert, Alberta, Canada. At the conclusion of this engagement, Mr. Pretyman returned to the Royal School of Mines and finished his course there in the next two years, receiving the degree, Associate of the Royal School of Mines, in 1913. In the same year he became a Fellow of the Geological Society of London. At the time of his admission to the Institute, in May, 1914, he was taking a post-graduate course in geology at Columbia University, New York.

CAPTAIN FREDERICK BENNETT REECE

Frederick B. Reece, who was a Captain in the Royal Engineers, 232d Army Troops Company, of the British Expeditionary Forces, was killed in action.

He was born in Liverpool, England, in 1877, and received his academic education in England. The year 1899 he spent in the shops of Lingford Gardiner & Co., colliery engineers, at Durham. In 1903, he entered

the College of Mines of the University of California, at Berkeley, and graduated in 1906. His summer vacation of 1905 was spent in timbering and machine drilling at the App mine, Tuolumne Co., California.

His first employment after graduating from the University of California was in El Oro, Mexico, where he spent two years with the Hacienda Vieja. In 1908, he was practising mining engineering at Lead, So. Dak., and in 1909 was engineer with the Socorro mine, at Mogollon, New Mexico. In 1910, he was with the Hidalgo Guadalupe, Pachuca, Mexico, and in 1911 was engineer with the Gualcola Mines Co., at Tuquerres, Colombia. In 1913, he returned to the Southwest, and was employed for that year by the Inspiration Cons. Copper Co. at Miami, and in the middle of the following year he became engineer with the Detroit Copper Co., at Morenci.

In the autumn of 1914, Mr. Reece, stirred by his English blood, resolved to return to England to take part in the war. At this time he wrote "I think it will be better for me to resign my membership. If I come through all right, I will apply for re-election." The Institute, however, instead of accepting Mr. Reece's resignation, voted him an indefinite leave of absence, and this precedent soon crystallized into the regular procedure, now in force, of remitting the dues of members in active service. On Dec. 17, 1914, he wrote from Montreal that he fully expected to go over shortly in the second contingent from Canada, with Borden's Armored Brigade, operating with armored motor cars. As he said "this will be active enough service to satisfy any enthusiast, as they are used generally for reconnaissance duty."

SOREN RINGLUND

Soren Ringlund died suddenly on July 24, 1918, at Fort Logan, Colo., where he was engaged in service with the Medical Department of the U. S. Army.

SOREN RINGLUND.

Mr. Ringlund was born in Denmark in 1875. He came to the United States in 1902, and became a citizen in 1908. He graduated as B. S. and E. M. from the School of Mines at Socorro, New Mexico, in May, 1912. Immediately after graduating, he began as a practical miner in the U. S. mines at Bingham, Utah, but in November, 1912, he entered the operating department of the Chino Copper Co.'s concentrator at Hurley, New Mexico, where he stayed until July, 1913. During the latter half of 1913, he was employed as chemist in the laboratory of the El Paso smelter, at El Paso, Texas. In December, 1913, he became engineer and geologist with the Empire Zinc Co., at Socorro,

New Mexico, which position he held at the time of his admission to the Institute in 1914, and until he entered the army in June, 1918. Before beginning the study of mining, Mr. Ringlund had completed a course in pharmacy, which accounts for his enlisting in the Medical Corps.

LIEUTENANT GEORGE ROPER, JR.

George Roper, Jr., a Junior Member of the Institute, was killed in an aeroplane accident near Shotwich, England, on May 25, 1918.

He was born at Steubenville, Ohio, in 1893, and at the time of his admission to the Institute in 1916 was a student in mining and metallurgy at the Massachusetts Institute of Technology, Boston, Mass., from which he received the degree of S. B. in June, 1917.

LIEUTENANT GEORGE ROPER, JR.

In August, 1917, he enlisted in the Royal Flying Corps, and after preliminary training on this side of the water, was sent to England. He was making the final cross-country flight of his course of training when the accident occurred.

NEW YORK MEETING, FEBRUARY 17–20, 1919

In preparation for the 118th meeting, New York, Feb. 17 to 20, 1919, the following committees have been appointed:

Committee on Arrangements

ALLEN H. ROGERS, *Chairman.* W. S. DICKSON, *Secretary.*
J. E. JOHNSON, JR. F. T. RUBIDGE. P. G. SPILSBURY.
H. C. PARMELEE. FOREST RUTHERFORD.

Committee on Annual Dinner

F. T. RUBIDGE.
E. B. STURGIS.

Committee on Luncheon

FOREST RUTHERFORD, *Chairman.*
E. MALTBY SHIPP.

Committee on Patriotic Meeting

H. C. PARMELEE, *Chairman*

WOMAN'S AUXILIARY—AMERICANIZATION COMMITTEE

Flag Day Celebrations Develop Practical Patriotism

Among the hundreds of industries which celebrated Flag Day on June 14, were a number of mines, and a report from the United States Smelting, Refining and Mining Co. tells how the programs were carried out at Mammoth and Chrome.

In the first place, Flag Day was not observed by knocking off work, but by short exercises, after which work was resumed with re-doubled energy. In this crisis, that method of showing devotion to the flag and country might be termed "practical patriotism." In other words, it could be expressed as "Hats off to the flag and sleeves up for it."

Harry Hunt, first-aid man at the Mammoth mine, reports that the flag raising was marked by the spirit of high enthusiasm, which included every man, woman and child belonging to the camp. "The miners in their working clothes, still wearing their carbide lamps on their caps, with faces covered with dirt, just as they came from the mine, and the ladies and children with their bits of bright color, made a picture worthy of the brush of a master painter. The program rendered was that arranged by the National Bureau of Education."

First came a bugle call, "To the Colors," given by Assistant Superintendent C. W. Plumb. Then Foreman Carpenter W. R. (Bill) Young, raised the stars and stripes to the peak, and as the banner unfurled to the breeze, all heads were bared, and the salute was given by the workers, whose toil at home is strengthening our army in France. Then the miners joined in the singing of the "Star Spangled Banner," and repeated the "Pledge of Allegiance," and the "American's Creed."

Shift-boss W. J. Phinazee then addressed his fellow workers, telling them how the flag stands for their protection and that of their loved ones, and how it should be loved and respected, not only by the native born, but by all who live here under its protection. Those of alien birth, who have come here because of the greater opportunities offered in America, owe a special honor to the stars and stripes, and the point was made that these men from other lands should not love their old home less, but their adopted country more. The majority of those present were foreigners, and their hearty applause showed that they appreciated the point made by their shift-boss, who, because of his position, was able to address them as man to man.

The brief ceremony closed with the singing of "America," after which tools were picked up and the day's work was resumed with more than usual energy.

It has been proposed that as many as possible of our holidays should be linked up with love of country, and that this love be expressed by devotion to the daily toil which strengthens our country. The shipbuilders set us all the right example when they made July 4th the occasion for launching a fleet that will aid directly to our success in this war. The Labor Day celebration this year is characterized as a day to "Splash the Kaiser" by a similar huge launching of ships. The mining industry, which is no less vital to our success in the war, can constantly hammer home the fact that the duty of a loyal American miner is to produce metal or coal, while the miner of foreign birth must see that the way to prove his devotion to his adopted country is to work for it whole-heartedly.

As the coöperation of the foreign-born is so essential to strengthening our industries and winning the war, we should make them realize that we appreciate their help. And while encouraging the emigrants from other lands to love and work for America, we should see to it that they are treated like Americans, given a chance to live like Americans by our own standard of living, and afforded every opportunity to learn our language and acquire citizenship. It is by such methods that we shall unite all races in America to win this war. MRS. C. C. BURGER, *Chairman.*

DIED IN SERVICE

Bailey, Lewis Newton, Master Engineer, Senior Grade, 4th Regiment, U. S. Engineers, Headquarters Company, died of pneumonia at Camp Merritt, N. J., on April 30, 1918.

Baird, Louis, Lieut., Royal Field Artillery, British Army, died on the battlefield in 1915.

Burt, Andrew, died in active service, 1916.

Cobeldick, William Morley, Royal Engineers, died from gas poisoning on October 7, 1915.

Dougall, Ralph, 4th University Co., Princess Patricia Regiment, killed in action early in the war.

Evans, Alfred Winter, Lieut.-Col., New Zealand Rifle Brigade, D. S. O., D. C. M., killed in action on October 12, 1917.

Gorman, Thomas C., Lieut., Canadian Engineers, killed in France, Mar. 18, 1918.

Hague, William, 1st Lieut., Engineer Officers' Reserve Corps, died in active service, Jan. 1, 1918.

Hall, William T., Capt., Royal Flying Corps, killed in action, May 19, 1917.

Heine, Bernhardt E., Lieut., Aviation Service, died at Fort Sill, Okla., Aug. 10, 1918.

Irving, John Duer, Capt., 11th Engineers, A. E. F., died July 26, 1918, while on active service in France.

Perry, Edward H., 1st Lieut., Co. D, 6th Regiment Engineers, U. S. Expeditionary Forces, France, killed in action on March 30, 1918.

Pretyman, Frank Remington, 2d Lieut., Royal Engineers, killed in action on June 17, 1916.

Reece, Fred. B., Capt., Royal Engineers, B. E. F., 232d Army Troops Co., killed in action.

Ringlund, Soren, Medical Department, Fort Logan, Colo., died suddenly in camp on July 24, 1918.

Roper, George, Jr., Lieut., Royal Flying Corps, killed in aeroplane accident in England on May 25, 1918.

NEWS FROM MEMBERS AT THE FRONT

K. Baumgarten has returned from active service in France. He reports that he saw C. W. Campbell, formerly with the 2d Engineers on the Chateau Thierry front, and believes that the latter returned to the United States on August 1. He also saw J. J. Croston; G. J. Sielaff, recently transferred to the Gas Service; Thomas M. Smither, survivor of the Tuscania after a 10-mile swim to Ireland. While in Paris he endeavored to see Prof. Sauveur, but was unsuccessful.

F. K. Borrow was given a commission as Lieutenant in the Royal Garrison Artillery in 1914, but had to relinquish it, on account of ill health, in August, 1915. His health has much improved and he hopes to resume active work toward the end of this year.

Davis, A. W., see British Columbia Engineers, below.

Alfred Fox, Jr., enlisted in the Public Schools Brigade, Royal Fusiliers, in September, 1914; was gazetted Lieutenant in the Royal Field Artillery in December, 1914, promoted to Captain in November, 1915, and Adjutant to 78th Brigade, Royal Field Artillery, in January, 1916. He was appointed Staff Captain of the 12th Divisional Artillery in November, 1917. He has served continuously in France since July 1, 1915. He was awarded the Military Cross in January, 1917, and four times mentioned in despatches.

E. Fraser-Campbell writes that he joined the London University O. T. C. in January, 1918, for five weeks; enlisted with the Argyll and Sutherland Highlanders in February, 1918, and attended a training course for officer cadets at Chatham for six weeks. He was commissioned 2d Lieutenant, Royal Engineers, in April, 1918. After two months on home training at Chatham, he landed in France on June 23, 1918, posted to 180th Tunnelling Co., R. E., and is now with his unit up on the line.

Major A. Hibbert, of the 3d Tunnelling Company, Canadian Engineers, B. E. F., joined the Forces in 1914 and went to France in June, 1915, where he has seen continuous service since as a mining officer. He is now commanding the above unit and has been twice mentioned in despatches, on Jan. 1, 1916 and again on Jan. 1, 1918. He was also awarded the Military Cross in November, 1915.

Walter Hooker, Lieutenant, Royal Engineers, writes from Palestine that the weather has been ideal; lots of sunshine, now and then heavy rain and a little cold at night, but a Paradise after the Balkans.

Captain W. Hutchison, of the Canadian Forestry Corps, France, writes that he has been with the Canadian Forces since the beginning of 1916, first with the infantry and then with the forestry corps. Until a few months ago he was with one of the companies; at present he has a detachment out on mill erection.

The Canadian Forestry Corps is an efficient organization and has established some wonderful records in France, in the way of production. Many of the companies operate close up to the line and know what it is to be shelled and bombed.

Reynolds, L. B., see British Columbia Engineers, below.

Harold Rickard, Lieutenant, Royal Engineers, obtained his commission in 1915, and has been sent to France twice in a tunnelling company.

Harold Whittingham was in Sardinia managing a group of mines, but left there in October, 1914, to join the British Forces. After three months at Woolwich, he was gazetted Lieutenant in the Royal Garrison Artillery and was sent out to Flanders. He was at Ypres sixteen months. He has been in several engagements, *viz.*, Hooge, Hill 60, 2d Battle of Ypres, and was mentioned in Sir Douglas Haig's despatch, for gallantry on the Somme. On November 30, 1917, he was reported missing, but some three weeks later it was reported from the war office, and afterward it was officially announced, that he was wounded and a prisoner of war in Germany. Owing to a wounded arm, while at Heidelburg he was recommended for internment in Holland, and he is still there under medical treatment. He is now Major of the 71st Heavy Battery, Royal Garrison Artillery.

British Columbia Engineers.—In August, 1914, there were nine mining engineers, all university men, who threw up their positions and left Nelson, B. C., to travel over 400 miles to enlist as sappers in the North Vancouver Engineers. They were A. W. Davis, Mining Engineer for the Consolidated Mining and Smelting Co. of Canada; Alfred Evans, Assistant Superintendent of the Silver King; W. Robertson of the Trail smelter staff; Cyril B. North, Manager of the Dundee mine, Ymir; L. B. Reynolds, Manager of the Eureka copper mines; W. B. Webster, mining engineer of New Denver; Thomas Brown, of Australia, with the Minerals Separation Co.; Bryan Terrance O'Grady, of the Dominion Government engineering staff, and George Revell, mining engineer of the firm of Green Brothers & Burden.

They were afterward transferred to the First Field Company, Canadian Engineers, and after short training at Valcartier proceeded to England with that company. In England, Sappers Brown and O'Grady were given commissions in English units. The remaining seven went to France in February, 1915, after further training in the art of being mud larks on Salisbury Plains.

Early in 1915, just after the second battle of Ypres, Lance Corporal North and Corporal A. W. Davis, in answer to a call for mining engineers for mining companies, left the Canadian Engineers and were given commissions in the tunnelling company. These two officers did so well that on the formation of the Canadian Tunnelling Company they were called back to the Canadian Corps and given command of two of the companies. For his work at Hill 60, Major Davis was awarded the D.S.O., and Major North was afterward given the D.S.O. for the part his company took in the blowing up of Messines Ridge. Major North had previously been awarded the M.C. for good work under fire.

Later on, Sapper Robertson and Sapper Webster received commissions in the company with North and Davis. Second Lieutenant Robertson paid the supreme price, being killed by a sniper's bullet in the Ypres salient. Curiously enough, Second Lieutenant Webster was struck a few nights later on exactly the same spot and in the same place on his body by another sniper's bullet. His life was despaired of, but after a desperate operation, over a year in hospital, and seven months rest, he returned to duty and was transferred to the Canadian Forestry Corps.

Sapper George Revell, after passing safely through the battles of Ypres and Festubert, was killed at the battle of Givenchy in 1915. Always keen, he went out that day in spite of the fact that his heel was raw and he was advised not to go. Of the little party of 23, only six came back alive, and two of them were wounded.

A few days before the battle of Givenchy, Corporal Alfred Evans left the company to become a Brigade Mining Officer, a position used as an alternative, on a front where mining was necessary, but no company was yet available. His going was keenly felt by his section, for he was beloved by all. He had already been mentioned in dispatches by Field Marshal Lord French, for his courage and good work during the second battle of Ypres. Shortly after his promotion, he was killed by a rifle grenade near "Plug Street."

Sapper L. B. Reynolds left the old company in November, 1915, and was given a commission in a mining company on the Somme. He was twice slightly wounded by bullets and in 1916 had his leg severely injured. He enjoyed four months rest in hospital and leave, recuperating from his wound and mine gas poisoning; returned to the front during the battle of the Somme, was twice wounded slightly again, once by a blow on the nose from a rifle and once with a piece of shell in his calf. Early in 1917, he was mentioned in the orders of the day by the Commander in Chief of the French army, General Nivelle, who decorated him on the field, in the presence of the famous Iron Division, with the Croix de Guerre with a palm. In the following August, he was buried by an eight-inch shell and suffered such injuries to his head, and also from concussion, that he has now been honorably invalided from the service. He was Captain Reynolds at the time of his retirement.

Majors North and Davis are still at the front with the Canadian Engineers. Captain Thomas Brown, M.C., was with the Royal Engineers in a mining company at the front when last heard from. Major O'Grady, M.C., was recuperating from the effects of a long campaign on the Salonica front. Capt. Webster is now a staff captain in the Forestry Service in France. These five are still carrying on. May their leave come soon and often.

ADDITIONAL LIST OF MEMBERS OF THE INSTITUTE IN MILITARY SERVICE

(The following list contains the names of those members of the Institute of whose connection with military service we have only recently become acquainted; it also includes the names of a few who have recently been promoted or transferred, indicated by a *. A complete list was published in the Year Book, issued as a supplement of the *Bulletin* for March, 1918.)

ADAMS, ARTHUR K., Lieut., Co. 2, E. O. T. S., Camp Humphreys, Va.

AMIDON, CLAUDE E., 11th Training Co., Casual Camp, Camp Cody, N. M.

*BARBOUR, P. E., Capt., Engineer Corps, U. S. A.

*BENHAM, W. M., Master Engr., Headquarters Dept., 115th Engrs. A. E. F., Care Postmaster, N. Y.

BICKNELL, H. L., Pvt., Co. D, 27th Engrs., Camp Leach, D. C.

*BLANDY, S. H. B., Lieut., Royal Horse Artillery, B. E. F.

BLICKENSDERFER, F. C., 1st Lieut., Ordnance Dept., Edgewood Arsenal, Edgewood, Md.

BROWN, FRANK HAROLD, Capt., Engr. R. C.

BROWN, S. R., Co. F, 27th Engrs., Camp Leach, D. C.

BROWNING, EDWARD, 1st Engineer Corps, A E. F., Care Postmaster, N. Y.

*BRUNS, C. L, JR., 2d Lieut., Aviation Section, U. S. A., Dorr Field, Arcadia, Fla.

BURFORD, S. W., Capt., Ordnance Supply Div., Rock Island Arsenal, Hotel Blackhawk, Davenport, Ia.

*BURG, R. S., 2d Lieut., 5th Reg., 15th Batt., F. A. N. A., A. E. F., Care Postmaster, N. Y.

BURROUGHS, A. H., JR., Ensign, U. S. Naval Reserve, Bureau of Ordnance, N. Y.

*CANTON, WILLIAM R., Pvt., Headquarters Co., 80th F. A., 7th Div., A. E. F.

CARPENTER, CLARK B., 2d Lieut., Co. B, 23d Engineers, A. E. F. via N. Y.

*CARSTENS, C. E., 2d Lieut., Care Director, Chemical Warfare Section, A. E. F.

CASE, WILLIS WHITTIER, JR., Sec'y, Selective Service Board, Div. No. 7, Room 203, City Hall, Denver, Colo.

CHAN, CLARENCE T.

* CHASE, J. L., Cadet No. 2011205, Canadian Engrs., Guy St. Barracks, Montreal, P. Q., Canada.

COLBURN; C. LORIMER, Capt., Engineers, Officers' Training School, Camp Humphreys, Va.

*COLEMAN, W. H., Corp., Co. E, 23d U. S. Engrs., A. E. F., France, via N. Y.

*CRAIG, JOHN J., 2d Lieut., 311th Engrs., A. E. F.

*CROSSFIELD, J. T. K., Lieut., Royal Air Force.

*DAVIDSON, LYNDALL P., 2d Lieut., 373d Aero Squadron, A. E. F.

DECKER, HAROLD DEWITT, Co. A, 27th Engineers, A. P. O. No. 714, A. E. F., Care Postmaster, N. Y.

DEWEY, GEORGE C., Pvt., Headquarters Co., 146th Machine Gun Batt., American P. O. 727, A. E. F., France.

*DICK-CLELAND, A. F., Capt., 172d Co., Royal Engrs., B. E. F.

*DOBSON, PERCY G., Railway Construction Co., C. E. F.

DOVE, D. R., Co. B, Training Detachment, University of Utah, Salt Lake City, Utah.

DUNCAN, DAN MCLEAN, 2d Lieut., 312th Engineers, A. E. F., Care Postmaster, N. Y.

*EARLING, ROY B., 2d Lieut., Headquarters Co., 57th Field Artillery, Camp Bowie, Tex.

*EDMONSON, H. W., Capt., Engr. Reserve Corps, 28th Engrs., A. E. F.

FORD, HAROLD P., U. S. Naval Reserve Force, Steam Engr. School.

*GATES, A. O., Lieut., U. S. Naval Reserve Force, U. S. S. *Marblehead*, Care Postmaster, N. Y.

*GRANT, ULYSSES S., IV., 2d Lieut., Textile Equipment Branch, O. Q. M. G., Room 59, 1800 Virginia Ave., Washington, D. C.

*GRAVATT, C. MARSHALL, Lieut., A. S., Sig. R. C., First Pursuit Group, 95th Aero Squadron, A. E. F.

*GREENAN, J. O., Lieut., 27th Engrs., Camp Leach, D. C.

GRENFELL, DONALD S., 121 Ambulance Co., 106th Sanitary Train, Camp Wheeler, Ga.

HARBICHT, HARLAN C., Lieut., Co. 12, Engr. Training Regiment, Camp Humphreys, Va.

*HAVLIN, THOMAS N., Capt., 138th Ordnance Depot Co., Las Casas, Porto Rico.

*HIBBERT, ARTHUR, Major, 3d Tunnelling Co., Canadian Engrs., B. E. F.

HOWELL, JESSE V., Field Artillery Officers' Training School, Camp Taylor, Ky.

*HURD, RUKARD, Major, Engr. Officers' Reserve Corps, U. S. Bureau of Mines, State Capitol, St. Paul, Minn.

HUSSISSIAN, K. L., Pvt., Co. 15th, Depot Brigade 161st, Camp Grant, Ill.

*HUTCHISON, WILLIAM, Capt., Headquarters 9th Dist., Canadian Forestry Corps, C. E. F.

JAMES, FLOYD D., Ensign, U. S. N., 10th Regiment, Submarine Unit, Pelham Bay Park, N. Y.

KENNEDY, H. DES., Air Service (Unassigned), U. S. A.

LOERPABEL, W. HARRISON, Mazomanie, Wis.

MAIER, HERMAN R., Lieut., Engr. Reserve Corps, 305th Engr. Train, A. P. O. No. 756, A. E. F.

MANESS, ORIE N., Co. D, 1st Replacement Engineers, Washington Barracks, D. C.

*MEAD, RICHARD, Battery C, 101st Field Artillery, School of Instruction, A. P. O. No. 711, A. E. F.

*MOONEY, JAMES D., Capt., 309th Ammunition Train, Camp Sherman, Ohio.

MURRAY, MALCOLM S., Capt., Engr. Reserve Corps, Co. 5A, E. O. T. C, Camp Lee, Va.

NELSON, H. C., Co. E, 314th Engineers, A. E. F.

*NOWLAN, HARRY H., 1st Lieut., Balloon Observation Corps, A. E. F.

NOWLIN, R. A., 2d Co., E. O. T. S., Camp Humphreys, Va.

PARTANEN, ISAK, Pvt., Headquarters Co., 213th Engrs., Camp Forrest, Ga.

*PEARSON, ALFRED, JR., Capt., C. E., U. S. A., Camp Humphreys, Va.

*PICKETT, CHARLES E., 2d Lieut., F. A. R. C., American P. O. No. 718, A. E. F.

PILL, JOHN R., Engineers' Committee, U. S. Fuel Administration, Washington, D. C.

PUTNAM, HENRY R., Capt., Engr. R. C., General Engineering Depot, Washington, D. C.

*RABLING, HAROLD, Act. Corp., 2d Draft Reinforcements, Field Engrs. Australian Imperial Forces.

*RAY, HORATIO C., 1st Lieut., Engr. R. C., Co. A, 514th Engrs., A. E. F.

*RICKARD, HAROLD, Lieut., Royal Engrs., Brompton Barracks, Chatham, England.

*RODGERS, GEORGE B., Principal Asst. Engr., Air Nitrates Corpn., Agent, Ordnance Dept.

ROGERS, ALEXANDER P., Aircraft Production, Production Dept., Chemical Section.

SCHEURER, L. R., Co. D, First Replacement Engrs., Washington Barracks, D. C.

SCHINDLER, DONALD F., 34th Co., M. T. D., Machine Gun Training Center, Camp Hancock, Ga.

SCHMIDT, R. D., Lieut., 324th Field Artillery, A. E. F., Care Postmaster, N. Y.

*SHRIVER, ELLSWORTH H., Lieut., 27th Regiment Engrs. (Mining), Co. C, A. E. F.

*SMALL, H. L., Capt., 32d Provisional Ordnance Depot Co., A. E. F.

STARBIRD, ROY, Pvt., Co. D, 63d Infantry, Presidio, Cal.

*STEVEN, HUGH M., Capt., 7th Batt., Canadian Engrs., B. E. F.

SYKES, W. P., U. S. Naval Aviators' Reserve Force.

TEETS, JOHN N., U. S. Naval Training Station, 15th Reg. Aviation, C. P. O. Barracks, Great Lakes, Ill.

*THURSTIN, ROBERT A., Lieut., Co. C, 308th Engineers, A. E. F.

TURNER, SCOTT, Lieut., U. S. Naval Reserve Force.

UREN, LESTER C., Capt., Chemical Warfare Service, A. E F.

VISEL, C. E., Co. 3, Engr. Officers' Training School, Camp Humphreys, Va.

WAITE, ALLAN G., 1st Lieut., Air Service, Military Aeronautics, South San Antonio, Tex.

*WALLOWER, HERBERT HOOVER, 2d Lieut., Co. B, 29th Engrs., American P. O. No. 714, A. E. F.

WARD, A. T., Co. F, 56th Pioneer Infantry, Camp Wadsworth, S. C.

WHITE, ROGER F., 2d Lieut., Co. D, 4th Engrs. Training Reg., Camp Humphreys, Va.

*WHITTINGHAM, HAROLD, Major, 71st Heavy Battery, Royal Garrison Artillery, Royal Hotel, Scheveningen, Holland. (Prisoner of War.)

WILSON, JOSEPH M., Asst. Inspector, Engr. Material, U. S. Navy, 1243 Russell St., Allentown, Pa.

WITT, HERBERT N., Naval Service.

WOOD, ROY U., Ensign, U. S. Naval Reserve Force, Section R, Bureau of Ordnance, Navy Dept., Washington, D. C.

WOLVERTON, F. M., Jefferson Barracks, Mo.

WORMSER, FELIX E., Co. 3, Engr. Officers' Training Corps, Camp Humphreys, Va.

WROTH, J. S., 1st Lieut., Engr. Reserve Corps.

THE NATIONAL ENGINEERING SOCIETIES AND THE NATIONAL RESEARCH COUNCIL

By George Ellery Hale*

(The following extracts from Mr. Hale's paper have been made by the Editor, as being of particular interest to our members.)

In an address delivered on May 28, at the kind invitation of the Engineering Foundation, I briefly sketched "The War Activities of the National Research Council."[1] The wide scope of my subject forced me to touch very lightly upon engineering; I therefore beg permission to return to this phase of the subject.

As shown in my earlier address, the charter membership of the National Academy of Sciences, organized in the midst of the Civil War,

* Chairman, National Research Council.

[1] *Bulletin* No. 140 (Aug., 1918), xxxix.

comprised a notable group of engineers. Indeed, engineering was the only one of the arts represented in the Academy, which based its elections, then as now, upon creative work and original contributions to knowledge. The war was the immediate stimulus that led to the establishment of the Academy, but the published opinions of well known visitors from abroad, particularly De Tocqueville[2] and Tyndall,[3] indicate that there was urgent need for such a body in this country.

The half century which elapsed before the United States was again stirred to its depths by another great war was a time of specialization, both at home and abroad. Once fairly launched, both science and the arts made rapid progress, but they inevitably grew apart. Indeed, the tendency toward specialization, which divided the arts from the sciences, also separated the sciences into many distinct groups and split the arts widely asunder.

It is plain that these effects of specialization, while natural and essential elements in the development of science and the arts, involve certain consequences which are far from advantageous. The underlying motive of the investigator, to advance knowledge and to improve practice through the utilization of new ideas, is common to all fields of action. His point of view is much the same, whether his problems be those of the biologist or the engineer. Moreover—and this is a matter of prime importance—the principles and methods of research developed in one field may be equally applicable in another. Thus there is an essential solidarity of research, which should bring into active coöperation the men engaged in all of its various branches. Recent experience, both in peace and war, has shown how effectively the physicist and chemist can join forces with the engineer; in fact, how men drawn from the most diverse fields can utilize their varied experience to common advantage.

The remarkable development of engineering in the United States is indicated by the success of the four great National Societies, which aggregate more than thirty thousand members. Nine-tenths of the work of the engineer is organization and construction rather than research. While the chief interests of the National societies thus lie in other fields, the importance of research is such as to demand a large measure of support from each of them. Moreover, great benefit will result from a joint effort, involving the coöperation of the National engineering societies with the National Academy of Sciences in a new and powerful movement to promote research in every branch of science and the arts.

It is natural that the first effective contact between the National Academy of Sciences and the National engineering societies should have been established through the Engineering Foundation, endowed by Mr. Ambrose Swasey. It is equally natural that the other engineers who took leading parts in the movement toward a consolidation of interests were also men fitted by experience to appreciate both sides of the question. The National Academy owes a special debt of gratitude to Mr. Gano Dunn, who immediately grasped the purpose in view, and has worked unceasingly toward its accomplishment. Others who were most active in the initiation of the movement, including particularly Colonel Carty and Dr. Pupin, also combine experience in research with exceptional capacity as engineers.

---

[2] "De la démocratie en Amérique," 17 ed., vol. 3.

[3] "Six Lectures on Light," 2d ed., p. 226.

The National Academy, probably because of the general tendency toward separate development of the arts and sciences already mentioned, failed to maintain on its rolls the same percentage of engineers with which it originally set out. At the annual meeting in April, 1916, however, the following resolution, presented by the Council, was adopted by the Academy:

That the Council express to the Academy the opinion that it is desirable that a section of engineering be developed which shall include men who have made original contributions to the science or art of engineering; that to this end the Council suggests to the Academy that the present section of physics and engineering be designated the section of physics, and that the Council, under the authority granted by section 4, article 4, of the constitution, nominate to the Academy, after inviting suggestions from the members of the Academy, two or three engineers each year until such time as it shall seem advisable to establish a separate section of engineering, any engineers elected as the result of such nominations being in the meantime assigned to that one of the existing sections to which their work is most closely related.

Since that time six eminent engineers have been elected to membership in the Academy, and the Section of Engineering will soon be established.

Another means of connection between the Academy and the engineering profession was initiated at the same meeting. Our relations with Germany, after repeated submarine attacks on merchant ships, were in a state of high tension, and the need of some preparation for coming war was plainly evident. The Academy's offer of service to the President was at once accepted, and the National Research Council was formed, at the President's request, for the purpose of federating the research activities of the country.

It is a matter of prime importance that in all researches bearing on the war, the scientific and technical societies of the entire country should work in close coöperation, both to avoid unnecessary duplication and to insure the utilization of all ideas and facilities available for the solution of the most difficult problems. The National Research Council affords the necessary means of bringing representatives of these bodies together and into contact with the various technical bureaus of the Army and Navy and other departments of the Government.

The constantly increasing demands upon Mr. Dunn's time made it necessary to select new officers to carry on the engineering work in Washington. Dr. Henry M. Howe was accordingly made Chairman, and Mr. W. J. Lester Vice-chairman of the Engineering Division, the purpose of which is described in the following excerpt from the remarks of Dr. Howe at the first meeting of the Advisory Committee of the Division.

It is to consider how we may best carry out this general purpose of "coördinating the scientific resources of the entire country," as regards engineering and how we may best "secure the coöperation of all engineering agencies in which research facilities are available" that we have been called together. We are asked to do something wholly new, and, by the intentional breadth of our charter we are, in effect, told to devise ways of doing it.

Our most pressing duty is to help the existing governmental agencies in every possible way to win the war, taking the attitude that, however perfect their several organizations, after all they are finite, that is, limited, whereas the demands which the most rapid possible development of our military strength makes on them are unlimited. We therefore seek and welcome ways of helping them. In general our natural function here has been to develop ideas, often initially nebulous, far enough to make their usefulness clear to the military authorities, and then to leave the active production to them.

Our own division has already formed five sections: on mechanical engineering, under W. J. Lester; prime movers, under Prof. Lionel Marks; metallurgy, under Prof. Bradley Stoughton; electrical engineering, under Prof. Stoughton and Prof. C. A. Adams; and military "tanks." The National Advisory Committee for Aeronautics acts as our section on aircraft. Our section on metallurgy has two important committees, on helmets and body armor, under Major Bashford Dean, and on smelting ores of manganese, under J. E. Johnson, Jr.

Since that meeting the work of the sections on mechanical engineering and on metallurgy has developed rapidly. The former has taken over the laboratories and machine shop of the Carnegie Institution at Pittsburgh so as to control the construction of the devices which it is perfecting. Through its Committee on Fatigue, under the chairmanship of Prof. H.E. Moore of the University of Illinois, it has begun the systematic study of fatigue phenomena, having especially in view the requirements of aircraft crankshafts and welded ship plates. It has brought the development of two special types of guns so far that one is now ready for firing, while the other will probably be fired before this paper is in print. Beyond this it is actively developing ten devices, a special gun for use in aircraft, a special mechanism for controlling it, a new control for aircraft, aircraft fuel, tanks of various types, mechanism for controlling trucks, a new type of tractor, special telescopes, special balloons, parachutes, and a new type of aircraft engine.

The work of the section on metallurgy promises to develop chiefly through the creation and direction of committees which shall mobilize the latent skill and patriotism in the metallurgical works themselves and in their laboratories, metallurgical, chemical and mechanical, and in the laboratories of our institutions of learning. Thus, in addition to the committees mentioned by Dr. Howe, this section has organized, under the chairmanship of Col. W. P. Barba of the Ordnance Department, a committee containing the metallurgists of the great ordnance works, Bethlehem, Midvale, Standard and the United States Steel Corporation, to formulate detailed directions for the procedure in making and treating steel ingots for objects needing the very best quality, such as cannon, shells, armor and crankshafts. Under the chairmanship of Dr. George K. Burgess, of the Bureau of Standards, it is now organizing a committee to develop a pyrometer for determining the temperature of the molten steel in the open-hearth and electric steel processes. Other committees with aims of this general class are projected.

The work of the Research Information Committee, which now has offices in Washington, London, Paris, and Rome, has been greatly expanded by the action of the Secretary of War in issuing the following general order to all scientific and technical bureaus of the War Department:

The Research Information Committee was formed to establish machinery by means of which the general staff of the Army, the various bureaus of the Army and Navy, the scientific organizations in the United States, who are working on problems connected with war production and invention, and the various committees of the Council of National Defense charged with work of this nature, may be put in touch with the developments and experimental work being carried on, not only in this country, but in Europe, and kept mutually informed of the state of development of work of this nature.

In pursuance of the order of the Secretary of War, establishing this Committee and in order effectively to do this work, it is vitally necessary that the utmost of cordial coöperation be shown by each of the bureaus and committees in question, with the Research Information Committee. To secure this the following is directed:

(*a*) All military bureaus requiring scientific and technical information are given official status on the Research Information Committee in Washington, D. C.

(*b*) Representatives of military bureaus or of research committees collecting information abroad will be instructed, by their chiefs, to put themselves into direct relationship with the joint committees of the Research Information Committee sitting in Paris or London, or later in Rome, in order that information be at once dispatched to the Research Information Committee at Washington, D. C. All communications of scientific investigations or research shall be routed through these channels, even though other channels are employed at the same time.

(*c*) Official means of intercommunication, such as memoranda, bulletins, and the like, between bureaus of the Army and committees for research shall be developed to such a degree of efficiency by the Research Information Committee that the distribution of information shall be practically automatic.

(*d*) Before sending officers or civilians abroad for investigation work, all Army bureaus or civilian research committees shall get in touch with the Research Information Committee at Washington, D. C., for information and guidance.

(*e*) The present method of routing information memoranda for file and distribution through the Military Intelligence Branch will not be discontinued.

The policy of the Information Service will be to render available to accredited persons all sources of information relating to research, both at home and abroad. Its chief function at present will relate to the war; but this naturally includes extensive duties of an industrial nature, in addition to more strictly military and naval work. Through the Scientific Attachés at the various embassies, the Army and Navy Intelligence Services, and the officers of the scientific and technical bureaus of the Government, and through various other agencies with which the National Research Council is in touch, a large collection of valuable information will be brought together and collated for easy reference.

The work of the Research Information Service, which has already led to the establishment of the position of Scientific Attaché by the State Department, is part of an extensive plan for international coöperation in research which is being developed by the National Academy of Sciences and the National Research Council. A detailed plan for coöperation among the Allies in all researches bearing on the war has been prepared by the Council of the National Academy, for submission at a meeting in London.

I may conclude this paper with a brief reference to the common interests of the National Engineering Societies and the National Research Council in the promotion and organization of industrial research. At a meeting in New York, on May 29, it was decided to organize the work of a section devoted to this subject, and to begin the publication of a series of bulletins on the value of research and the advantages resulting from the establishment of research laboratories. Here is a field where the engineering societies and the Research Council can coöperate to special advantage through the Engineering Foundation, which is already taking an active part. The possibilities of developing this field, through the establishment of special laboratories and by other means, are obvious, and advantage will be taken of the present opportunity to influence favorably the industries which have led to appreciate the value of research.

U. S. NAVY STEAM ENGINEERING SCHOOL

The U. S. Navy Department has perfected plans for the enrollment and training of considerable numbers of engineering officers. A school for this purpose, the U. S. Navy Steam Engineering School, has been established by the Department at Hoboken, N. J.

The school is open to men between the ages of 21 and 40 who meet the physical requirements of the Navy, who are of thorough ability and officer-like character and who have completed the mechanical or electrical engineering course at certain recognized technical schools, or who possess an education and experience adjudged to be an equivalent thereof.

Enrollment in the U. S. Naval Reserve Force of men properly qualified may be made at any Naval enrolling office, notation being made of the applicant's qualifications and desire to be detailed to this school. Applicants will be enrolled as Chief Machinist Mates, and during the course of instruction will draw the pay of this rating, $83 per month, plus $60 per month paid as subsistence. Upon graduation, men will be commissioned as Ensigns in the U. S. Naval Reserve, with a salary of $1700 per year. The duty to which a graduate of this school will be assigned will be that of an engineer officer in the auxiliary service of the Navy.

Special provision has been made for the continuance of the school with proper material by a Navy regulation which permits undergraduates of the Freshman, Sophomore, and Junior Classes in recognized engineering schools to enroll in the Naval Reserve Force with the rating of Seaman 2d Class, and continue their courses at the institutions where they have matriculated. Such men will be called into active service after their graduation, and can at that time, if they are qualified to pass an officers' physical examination, apply for admission to the U. S. Navy Steam Engineering School.

Men who are registered in the draft, either graduates or undergraduates, may enroll with the proper enrolling officer by securing from their draft board a letter of release, which in all probability can be obtained for this purpose.

The aim of this school is not simply to produce engineers, but to produce naval engineering officers in the true sense of the word. The course of instruction covers a period of five months, arranged in four periods.

The first period is spent at the Pelham Bay Training Camp, New York. By means of drills and strict military discipline we so train the man that he understands both the value and the meaning of discipline. This period is from three to four weeks in duration.

The second period is spent at the Navy School in Hoboken, N. J. There, in five weeks, the man studies the characteristic construction of machinery used aboard ship. A week is spent on boilers; a week on propulsive machinery; two weeks on auxiliary machinery and a week on operation. The week on operation is given so that the man may better utilize the training of the next period. Lectures, quizzes, and sketch periods occupy the day, and the entire evening is spent in study. A drill period is also included in the afternoon.

The next period is called the Applied Course, and is spent on board various classes of ships, such as tugs, ferry boats, and Sound steamers operating in New York Harbor and Long Island Sound. The final

part of this practical training consists of a cruise over seas on a naval transport or cargo ship.

At this stage of training, a student is given the rank of Warrant Machinist (at a pay of $1500 per year) so that he can actually take charge of a steaming watch. The aim is to teach the operation of a marine plant, including adjustments and minor repairs such as are made aboard ship.

After the man has completed the Applied Course he is sent back to the barracks for further examination and study. It is felt that the future engineer officer must not only know how to operate a given type of equipment, such as may be found on a single ship, but must also be familiar with all standard machinery in use on other ships. He must also be resourceful enough to keep the plant in operation under all conditions.

At periods during the course the student visits boiler shops and engine shops and sees the actual construction of boilers and engines. Upon graduation the student is commissioned as an Ensign, U. S. N. R. F., with a salary of $1700 per year, and is detailed for engineering duties on navy, transports and cargo ships.

For further information, write to the assistant district enrolling officer 102 Customhouse Bldg., New Orleans, La.

U. S. EMPLOYMENT OFFICE

The United States Employment Office of the Department of Labor, of which the division of engineering and education, under the direction of A. H. Krom, maintains an office at 29 La Salle Street, Chicago, Ill., is engaged in a classification of engineers in order to make their services more readily available in case of need. We have received a form used by this division, on which it requires only a very little time to indicate one's particular line of work, his experience and the salary that he desires.

We have been asked to impress upon members of the Institute the distinct advantages that come through registration. Filling out the blank entitles an engineer to free employment service, provides him with direct contact with the Government, supplies him with information in regard to engineering affairs, and helps him to become successful in his profession. The Government wishes every technical man to register, so that it may know the strength and location of the engineering reserve. It is therefore the duty of every patriotic engineer, whether he needs a position or not, to register at once. Blanks can be obtained by addressing the office above noted.

A MIDSUMMER MISSION TO ENGINEERS

Between July 10 and August 15, 1918, the Secretary of United Engineering Society, of Engineering Foundation, and of Engineering Council visited 17 cities which are headquarters for large numbers of engineers. His mission was to tell men in all branches of the profession about "Centralized Activities of National Engineering Societies." Stops were made at Denver, Salt Lake City, Reno, San Francisco, Sacramento, Portland, Seattle, Spokane, Anaconda, Butte, Duluth,

St. Paul, Minneapolis, Milwaukee, Chicago, Cleveland, and Buffalo. Everywhere, the Secretary had a cordial reception, his message was listened to with interest, and helpful suggestions were gathered. Many men expressed astonishment at the extent of the united activities of the Founder Societies, and few, if any, had an adequate conception of what had been accomplished.

Few persons were prepared to give opinions or make suggestions at the time, because knowing so little of what had been done. Little faultfinding was heard, and none was important. Further opinions and suggestions are expected by correspondence. Everywhere there was a cheerful readiness to help, and a strong desire for the local groups, even at great distances from New York, to have larger and more active shares in the work, particularly in connection with the war.

Most impressive among my observations were the importance of the local group as a fundamental unit of organization, the strong tendency in local groups to embrace all kinds of technical men in the locality, the number of engineers not in any society, and the comparative weakness of engineers in many fields of professional and public service because of their lack of a complete, effective, national organization built up from the local groups and in close coöperation with them.

In most of the cities visited, one or more of the Founder Societies have local sections. In some places the local societies and sections have been associated by some form of organization; in other places such organization was in progress, and elsewhere it was desired, although a method had not yet been worked out.

Creation by the American Society of Civil Engineers of a development committee to study thoroughly matters of organization was generally approved. More than a few persons suggested that all large national societies should have similar committees, and that in some way these committees should work together. Several times the opinion was voiced that there should be but one national engineering society, including all professional engineers. A few men who had given this matter thought believed that in such a national society there should be two grades, Member and Junior, with provision for Associates, men who are not engineers but allied in their interests. Requirements for membership should be higher than those of the American Institute of Mining Engineers, but possibly not so exacting as those of the American Society of Civil Engineers. Local societies suitably organized or reorganized should be branches of the new national society, but might have a grade of local members for which requirements were distinctly lower. Men in this lower grade would not be members of the national society, and would pay smaller dues, for local purposes only.

Some agency to deal with employment and other personnel matters seemed to be desired, and preference appeared to be for a central organization having branches in a number of cities or definite coöperation with the local societies. So far as opinions were obtained, they advocated that this function should be performed by Engineering Council, or some other subsidiary of United Engineering Society, rather than by another national organization, which has sought to enter this field.

Almost everywhere appreciation was expressed of the usefulness and necessity of as complete registry of the engineers of America as could be compiled at Headquarters. Many local societies wanted copies of their portions for local uses. In many places it was the belief that this

work could best be done through the agency of the local societies. A number of these societies definitely offered to pay for a supply of the classification sheets, to distribute them to all engineers in their districts (including those not members of any society), to collect these sheets and forward them to Headquarters; also to assist in keeping the files up to date. A suggestion which met with general endorsement was first made in Seattle. It was to the effect that three blank classification sheets should be sent to each engineer, one for Headquarters, one for the local society, and the third for the individual's own file, if desired. In general it was assumed that Engineering Council would do this work and some regret was expressed that greater progress had not been made during the past year. Several local societies were about to undertake local registration independently.

Opinions about the proposed Engineering Societies *Journal*, in the few places where expressed, were favorable; indeed, some persons were enthusiastic about it and they were among the older men. It was suggested that the engineering profession should have a high-class, non-technical journal in which could be printed interesting news about engineers and their current work, and suitably illustrated articles on engineering subjects, of high literary quality, so written as to interest and inform the public as well as engineers; such publication could be the profession's own authoritative medium for the expression of opinions on professional affairs and on these public affairs in which the profession is interested. It was the opinion of some that this *Journal* should be supplied to members of each national society as a part return for dues, and that much of the expense of publication would be met by outside subscriptions and income from advertisements. The *Journal's* advertising policy should be absolutely independent of business considerations, and this should be unequivocally maintained from the outset.

In two or three places it was suggested that United Engineering Society, either directly or through Engineering Council, should make overtures at this time toward bringing together leaders of all important national engineering societies (for example, the president and secretary of each such society) for the purpose of determining a system of local and national organizations which would satisfactorily include all engineers. Frequent reference was made to the type of organization adopted by the American Medical Association.

It is unnecessary to burden this report with a list of the names of persons met in the cities visited, or other details. With two exceptions, leaders of the several branches of the profession were met in each city, either individually or in conferences. The Secretary's message, or portions of it, were printed in some of the local newspapers and in several local and national technical journals. In manuscript form it has been sent to selected individuals in many places not visited, so that it has gone to engineering groups in almost every state of the Union.

In conclusion, it should be stated that the visit was of evident benefit. In several places, it was remarked that by this visit the distance between the local societies and Headquarters in New York had been reduced by a great many miles. With your approval, the Secretary proposes to make other such visits as opportunities may offer, first to those portions of country not yet visited. In no better way can the bonds between outlying units and Headquarters be kept strong.

ALFRED D. FLINN, *Secretary.*

TO THE RESCUE OF GOLD MINING

An "international gold conference" was held at Spokane, Wash., on Sept. 5, 1918, under the auspices of the Northwest Mining Association, which was attended by a large number of engineers, mine operators, and bankers, representing the northwestern states, as well as Alaska and British Columbia. The principal subject under consideration was the doleful condition of the gold-mining industry, gripped between the diminished purchasing value of its product, and the increased cost of its operation.

Two resolutions were adopted by the meeting. The first approved the resolution adopted Aug. 12 by the American Gold Conference, a permanent organization formed at Reno, Nev., in which it is stated that relief by the United States to the gold producers of this country should be made to correspond with the increased cost of production, the extent of the relief to be fixed from time to time to meet changing conditions.

The second resolution, adopted after serious and long-continued discussion, was introduced by F. A. Ross, mining engineer, of Spokane, and a member of the Institute, and was as follows:

WHEREAS, it is now clearly understood and agreed by the allied nations that national gold reserves must be augmented without delay if rapidly expanding credits are to be secured; and

WHEREAS, at this time, the production of gold is daily decreasing to an alarming extent because of well known conditions that render the mining of gold-bearing ores unprofitable; and

WHEREAS there is no way by which the mining of gold-bearing ores may be made profitable except by the direct aid and influence of the government; and

WHEREAS the government has appealed to the mining industry for practical information and practicable suggestions upon this subject; therefore, be it

RESOLVED, by the International Gold Conference of the Northwest Mining Association, assembled at Spokane, Washington, Sept. 5 and 6, 1918, and representing Alaska, British Columbia, Washington, Idaho, Montana and Oregon, that the following topical suggestions for an improvement of the gold situation be offered to the authorities, in the hope and belief that they will prove effective if properly elaborated and applied, either singly or in combination, as the case may require:

First.—That the grant of priority rights in the purchase and transportation of materials, machinery and general mining supplies be enforced, and that, as far as possible, such items of expense as taxes and freight rates be restored to pre-war levels.

Second.—That the labor necessary to the operation of mines producing gold-bearing ores be assigned to them.

Third.—That main lines of motor-truck roads be built from railroad points into the distributing centers of promising but commercially inaccessible gold fields; for instance, such as those of central Idaho. Also, that trails or wagon-roads, connecting with these main roads, be opened to promising camps in cases where the routes thereto lie through government reserves.

Fourth.—That financial aid, or credit, be extended to such individual properties as may be judged by government specialists to be capable of producing appreciable quantities of gold or other metals essential to the conduct of the war.

Fifth.—That a bounty be paid upon every ounce of *new* gold produced by the mines of the nation, the amount of which bounty shall, from time to time, be determined by the proper authorities to be sufficient to encourage the mining of gold-bearing ores by insuring a reasonable profit therein; the said bounty to be considered a permissible war expedient and expense that in no way affects the international, or standard, value of gold.

RESOLVED, that this International Conference approves the arguments and general plan outlined in the monograph entitled, "The Proposed Bounty on Gold," which is attached hereto and made a part hereof; and that the same is respectfully recommended to the authorities for consideration.

RESOLVED, That copies of these resolutions be forwarded to the proper authorities at Washington, D. C., and Victoria, B. C.

The monograph above referred to as having been approved by the conference was prepared by Frank A. Ross, and reflects ideas which he has been advocating for a considerable length of time. The principal features of Mr. Ross' suggestions are indicated by the following extracts from his paper.

The Proposed Bounty on Gold

All new gold is obtained either from true gold mines and placers, or from the ores of other metals in which gold is considered a byproduct; therefore, any bounty that is offered for new gold must apply equally to both classes of gold-bearing ores as well as to the products of their reduction.

There is a vast difference between granting a bounty for the production of gold and decreeing an increase in the standard value of an ounce of gold. The former is a national affair while the latter an international one with which we are in no way concerned at this time. Moreover, the former is permissible and practicable, while the latter is fraught with dangerous financial complications too far-reaching for contemplation, if used as an expedient.

The objection is offered by many that any bounty on new gold would immediately operate to cause the melting of old gold in the form of plate, jewelry, and coin, for the sake of obtaining the premium. This objection is held to be groundless, for the following reasons:

In the first place, workmanship and successive profits accruing from their manufacture and sale give to gold plate and jewelry a market value considerably in excess of the value of the gold contained in the alloys from which they are made. It is scarcely probable that the bounty would be fixed at so high a rate as to tempt owners of such articles to melt them and then to take the chance of disposing of them as new bullion, contrary to special statutes that may quickly be enacted to cover the case.

Again, as to the melting of coins there is nothing to fear for two reasons: first, because the practice of hoarding gold coins is not general in this country, or Canada, as it is in other countries, for example, in India. Consequently, the total amount of gold from this source that might be offered fraudulently as new gold is probably very small.

But, granting that it might possibly reach considerable proportions, there is still another reason why this contingency is not to be greatly feared, namely, the existence of laws so drastic that few would care to run the risk of mutilating or melting coins for the sake of the bounty, even were it possible, through connivance, to incorporate them with new bullion.

Another objection is, that, unless all other nations proclaimed a corresponding bounty, the difference between the actual cost of our gold and the gold of other countries would operate against us in the settlement of balances. However this might work out, it is fair to assume that a bounty would probably be accounted a war expense, chargeable to profit and loss.

Finally, the objection is urged that foreign countries would send in their gold and claim the bounty. Gold bullion does not enter a foreign country except in exchange for commodities and subject to the surveillance of the authorities of that country; or when specially ordered thereby. Certainly no bounty would be paid on smuggled bullion under any plan like that outlined below.

Let a bounty be granted on all *new* gold produced, but under these, or similar, conditions:

1. That gold bullion and crude alloys containing gold shall be bought only upon identification of their possessors, after a satisfactory explanation as to their origin; purchase to be made at such places as may be designated, notably at the mint or at certain refineries.
2. That applicants for bounty payments shall present properly certified settlement-sheets from the mint, or refinery, that bought their bullion, or crude alloys; or else from the public mills or smelters that bought their ores.
3. That all such settlement-sheets of the public mills, smelters or refineries shall be officially certified by Government Inspectors of Ore Shipments.

A brief consideration of the above outline will show that when these precautionary measures have been carefully worked out in detail they will cover every case that may arise, without introducing burdensome complications.

In safeguarding a bounty grant, Congress may quickly enact statutes heavily penalizing the sale or delivery of gold bullion, or crude alloys containing gold, to any person, firm or corporation, whether public or private, except such as may be authorized to receive it, under stringent regulations as to identification and origin. Thus

it should be easy to safeguard gold to such an extent that the mere possession of it in the form of a refined bar, or crude alloy, would call either for a satisfactory explanation or for the arrest and conviction of the person holding it, thereby reducing the probability of fraud to a minimum.

Government Inspector of Ore Shipments

It will be noted that in suggestion (3) above, mention is made of a Government Inspector of Ore Shipments.

Since a large proportion of gold is produced as a byproduct of the ores of other metals, and because this fact appears to have somewhat confused the question of a bounty on new gold, the idea of creating the office of Government Inspector of Ore Shipments is advanced as a practical solution of the problem.

Although this innovation is now proposed solely as a war measure, calculated to increase the production of gold by immensely bettering the entire mining situation, yet it is, in fact, a step toward governmental supervision of public mills, smelters and refineries, but it is not in any sense intended as an indorsement of government ownership or control. The former may prove a progressive step of incalculable value; the latter might result disastrously.

It is axiomatic that every shipper of ore to a public mill, smelter or other reduction plant, is entitled to personal representation while his ores are being valued by the critical process of weighing, crushing, sampling and assaying. Heretofore, the heavy shippers alone could afford to employ representatives to supervise this process and guard their interests; the small shipper, with few exceptions, is forced to forego this protection.

Nothing herein contained is to be construed as an arraignment of the commercial methods of public mills, smelters or refineries, yet it is believed to be a fact that by far the greater part of popular distrust of such plants, and of the bitter agitation against them, has always been due to this lack of personal representation during the critical process of sampling.

The unrepresented mining public has come to the belief and even conviction, that it often fails to receive its just due at the hands of those to whom it consigns its valuable ores unchecked; and no power on earth, perhaps, short of the government itself, can now change that conviction.

Being forced to ship their ores on trust, and compelled to accept the sampling of the consignees, shippers are very naturally left in doubt on the question of fair treatment; and doubt nearly always breeds suspicion and deep resentment. But once let confidence be restored by the seal of government, wisely impressed, not only must suspicion and resentment vanish but a fresh impetus will also be given to mining in general; for it is perhaps no exaggeration to state that the inability to employ either a personal representative at the public plants, or a private assayer and chemist to check them, discourages development to a considerable extent.

Now, having briefly diagnosed the complaint, let us consider a potential remedy in the following outlined plan:

Let competent assayers and chemists, experienced in the proper methods of sampling and valuing ores, be sworn, commissioned and assigned to the relatively few public plants receiving and buying gold-bearing ores or crude alloys containing gold.

Let these uniformed officials bear a title, say, of "Government Inspector of Ore Shipments," representing the shipper only, and give them assistants necessary to a personal supervision of the weighing, moisture determination, crushing, sampling and assaying of every lot of ore consigned to the plants to which they are assigned; supervising the sampling and assaying in the case of crude alloys.

Let these Inspectors have such definite or discretionary powers as will enable them to protect the best interests of the shippers, following the same general procedure adopted by the personal representatives of the heavy shippers.

Let these Inspectors certify to every settlement-sheet remitted to the shipper, stating that they, or their sworn assistants, are satisfied with the same.

Having received this certified settlement-sheet, let the shipper now present it to the proper department for payment of the bounty due upon the *net gold value** of his ores, or crude alloys containing gold, as shown by the said sheet.

Privately owned and operated placers, stamp mills, cyanide plants, smelters or other plants and properties producing gold bullion acceptable at the mint, would present the mint certificates themselves as a claim for the bounty.

Public smelters and other plants that also treat their own ores, or products, would

*That is: "Gross *ounces* less percentage deduction for loss"—generally about 5 per cent.

render duplicate settlement-sheets to a government accounting office, including settlements for their own ores; or, they might be permitted to collect bounty periodically on the difference between the value of all the gold they turn over to the mint and the bounty due, or paid, upon the custom ores treated in the same period. Such matters as these may be left to those that would be commissioned to work out the details of the system, but they do not offer insurmountable difficulties, as far as can be foreseen.

In this way, no bounty would be paid to anyone except to the one for whose encouragement it was granted; that is to say, to the miner himself—to the original producer of gold, whether it be an individual or a corporation, public or private.

If the above outlined plan were to be carefully elaborated, there is reason to believe that it would prove unexpectedly simple, satisfactory, effective and relatively inexpensive. The gross expense to the government would undoubtedly be insignificant compared with the benefits conferred and received.

In fact, such a plan for the regulation of a bounty on new gold, taken in connection with the betterment of all other conditions that now render the mining of gold-bearing ores unprofitable, would doubtless not only result in a pronounced increase in gold production but it would, in all probability, bring about beneficial results not now foreseen which would necessarily follow an increase of confidence in the mining industry.

Finally, as to the probable attitude on this question, of the public mills, smelters and refineries themselves, it is inconceivable that any objection should be offered to so reasonable an arrangement, in view of its justice and also of the direct benefit to themselves to be gained by a much better business relation to the mining public.

DULUTH ENGINEERS' CLUB

The Duluth Engineers' Club was formally organized on the evening of Aug. 5, 1918, at a meeting attended by over 100 members of the several engineering professions. W. G. Swart, a member of our Institute, was elected the first President of the Club. At the organization meeting, an opportunity was given to Alfred D. Flinn, Secretary of the United Engineering Society, to outline the assistance that is being rendered to the Federal Government in the present contingency by members of the engineering profession. Membership in the Duluth Club is to be open to mining engineers on the iron ranges as well as to the residents of the city of Duluth.

TRANSACTIONS

We regret to advise that, owing to unusual pressure of business at our printers, Volume LIX will not be ready for distribution so early as was announced in the last Bulletin. It will probably be distributed in November.

Volumes LVII and LVIII were mailed during the month of August to all members whose dues were paid on Aug. 1; members who failed to receive their *Transactions* within a reasonable time are requested to notify the Secretary. In the case of members who have recently changed their addresses, the *Transactions* were sent to addresses on record on Aug. 19; those who did not notify us of change of address until after Aug. 19 will find their *Transactions* at the old address.

PERSONAL

The following is an incomplete list of members and guests who called at Institute headquarters during the period Aug. 10, 1918 to Sept. 10, 1918.

Amil A. Anderson, Hill City, S. D.
H. G. S. Anderson, Hurley, N. M.
Louis A. Barton, Capt., Engineers, U. S. A.
K. Baumgarten, 1st Lieut., U. S. R.
Charles W. Boise, Belgian Congo.
Henry C. Carlisle, The Pas, Manitoba.
J. Ross Corbin, Boyertown, Pa.
S. Le Fevre, Forest Glen, N. Y.
Harold P. Ford, Cleveland, O.
William L. Hogg, Waynesboro, Va.
A. A. Holland.
Paul S. King, Wilmington, Del.
Herbert G. Officer, Washington, D. C.
A. B. Parsons.
Robert R. Pollock, San Francisco, Cal.
Frank A. Smith, Edgewood, Md.
Edward C. Thompson, Kennett, Cal.
Malcolm M. Thompson, Morsemere, N. J.
Lester C. Uren, Berkeley, Cal.

Harold W. Aldrich has been appointed assistant general superintendent of the Inspiration Consolidated Copper Co. at Inspiration, Ariz.

Capt. Percy E. Barbour, formerly with the New York State Troopers, has been granted a leave of absence from the Department for the period of the war, by the Governor, and has been appointed Captain in the Engineer Corps, U. S. A. He served on the Mexican border in the New York State National Guard.

A. C. Barke, formerly with the United States Smelting, Refining and Mining Exploration Co., has accepted a position with the United States Fuel Co. at Salt Lake City, Utah.

H. C. Bellinger, general manager of the Chile Exploration Co., has recently returned from Chile.

R. W. Brock, who has been in England for the last two years on military duty, has been chosen by the Imperial authorities as geologist with the British Army in Palestine, and has been instructed to proceed to the Holy Land to take up his new duties there. Mr. Brock was until recently dean of the faculty of applied science at the University of British Columbia.

Forrest B. Caldwell, of the California State Bureau of Mines has arrived at Medford, Cal., as the representative of the U. S. Bureau of Mines, to examine the chrome deposits in Jackson County, after having completed a similar survey in Siskiyou County.

Jerome A. Chevalier, formerly geologist for the Carter Oil Co. and recently engaged in consulting work at Muskogee, Okla., has accepted a position with Mr. J. Edgar Pew of the Sun Co., with headquarters at Mineral Wells, Tex.

Samuel W. Cohen has returned to Montreal after a month's tour of inspection of mining properties in Northern Ontario, Nevada, and Colorado.

S. K. Dahl, mill superintendent for the Messina (Transvaal) Development Co., Ltd., Zoutpansberg, South Africa, until the closing down of the property, has severed his connection with the company and will return to the United States.

Joseph Daniels is now with the S. E. Junkins Co., Ltd., at Vancouver, B. C., Canada.

Algernon Del Mar is now manager of the Techatticup mines, El Dorado Canyon, Nev.

Gustavus A. Duncan has been appointed general manager of the Eldorado-Flagstaff Mining and Milling Co., at Nelson, Nev.

F. N. Flynn, general superintendent of the smelting and refining departments of the Consolidated Mining and Smelting Co. of Canada, Ltd., at Trail, British Columbia, has resigned. Mail addressed care of the American Institute of Mining Engineers, New York City, will be forwarded.

Waldemar F. Henniger has returned from Tampico, Mexico, and is at present in the employ of the Gulf Production Co. at Fort Worth, Tex.

Thomas F. Higgins has severed his connection with the Nichols Copper Co. of Laurel Hill, L. I. and has accepted a position with the American Smelting and Refining Co. at Caldera, Chile, S. A.

Jacob M. Holt, formerly connected with the Colonial Collieries Co. at Natalie, Pa., has now accepted a position with the Thomas Colliery Co. at Shenandoah, Pa.

K. K. Hood has accepted a position with the American Zinc, Lead and Smelting Co. at Carterville, Mo.

Herbert C. Hoover has paid a visit to the American battle front. Among the places he visited was Belleau Wood.

J. N. Houser, Vice-president and manager of mines of the American Zinc, Lead and Smelting Co. at St. Louis, Mo., is now connected with the American Zinc Co. of Tennessee at Mascot, Tenn.

Lee O. Kellogg has returned from Ecuador. His address is: South American Development Co., 15 Broad Street, New York City.

Hugh B. Lee, who was acting manager of the Porcupine Crown mines, which have closed down, has accepted the position of general superintendent of the Chrome mines of the Mutual Chemical Co. of Canada Ltd., under Dorr Co. management.

J. F. Linthicum has resigned his position as chief chemist of the No. 2 Works, Aluminum Ore Co., East St. Louis, Ill.

O. McCraney has resigned as general superintendent of the White Caps Mining Co. to undertake the superintendence of the Belmont Shawmut Mining Co. at Shawmut, Cal.

J. N. Mahoney, for 12 years a member of the engineering department of the Westinghouse Electric and Manufacturing Co., has tendered his resignation and intends to open consulting offices in New York City.

Dentaro Matsuzawa is now chief of producing department of the Nippon Oil Co., Marunouchi, Tokyo, Japan.

John T. Morrow has been appointed chief engineer of the Marlin-Rockwell Loading Co., Agent, Wilmington, Del.

John F. Murphy, formerly assistant professor of mining at the School of Mines, University of Minnesota, is now employed at the Draper mine, Calumet, Minn.

George A. Packard has returned to his office at 50 Congress Street, Boston, Mass., after having been absent on consulting work in the West for five months.

Irving C. Purington is now employed with the United Verde Copper Co., at Clarkdale, Ariz.

Henry D. G. Reynolds has just returned from the Altai District of Siberia, having been at the properties of the Irtysh Corporation, Ltd., of London.

Forest Rutherford, consulting engineer, is in Colorado making an examination of some large mining properties.

Charles A. H. de Saulles is now general manager of the American Smelting and Refining Co. at Denver, Colo.

W. C. Schmidt, formerly townsite engineer with the Consolidated Arizona Smelting Co. at Humboldt, Ariz., is now mining engineer with the same company at the Bluebell mine, Mayer, Ariz.

Prof. Theodore Simons, of the Montana State School of Mines, has returned to Butte from a two-weeks' visit to Philipsburg, Mont., where he investigated the manganese mining and milling problems of the district for the U. S. Bureau of Mines.

O. W. Steele is now employed with the Burro Mountain Copper Co. at Tyrone, N. M.

Hubert N. Stronck is now chief of operations with the Kenfield-Lamoreaux Co. at Chicago, Ill.

W. G. Swart was elected President of the Duluth Engineers' Club, at its organization meeting on August 5, 1918.

Frank W. Tickner is employed with the Frontier Brass Foundry, at Niagara Falls, N. Y.

A. A. Turner has severed his connection with the Goldstone Mining and Daggett Reduction Companies.

Frederick A. Weymouth, formerly with the Maryland Steel Co., has accepted a position as sales metallurgist with the Bethlehem Steel Co., South Bethlehem, Pa.

W. W. Wishon, of Searchlight, Nev., is making some examinations in Montana for Los Angeles and Montana interests.

POSITIONS VACANT

No. 345.—Assayer. A man 35 years old, or over, experienced in general mineral assaying, particularly of tin and tungsten ores. To locate in Bolivia with a strongly established house.

No. 346.—A firm of consulting and managing engineers, having charge of certain coal-mine properties in Illinois, requires the services of the following:

(*a*) Mine transitman, who has had underground experience and is capable of making accurate surveys. Salary \$150 per month to start.

(*b*) Mining engineer, possessing strong personality, and experienced both in surface and underground work, who is capable of taking complete charge of several coal properties. Salary \$175 per month.

(*c*) Four rodmen for mine surveying. Salary \$85 per month to start.

Candidates for the above positions should be able to report to the company's Illinois office at once.

No. 347.—A South African development company will shortly require the services of a mill superintendent, who has a general knowledge of concentration, particularly of flotation, and is able to take charge of a copper concentrator treating 15,000 tons per month and employing 200 natives and a small number of white men.

Salary is £60 per month to start, and the company supplies an unfurnished room or house, including free light, free water and free sanitary service, together with one native house servant. A contract will be made for six months, and notice of three months by either party will be required to terminate the engagement after six months. An allowance of £75 for travelling expenses will be paid on arrival in South Africa to a single man, or £125 to a man who brings his family. Salary begins upon arrival

in South Africa, and no allowance will be made for return travelling expenses. Information as to the general climatic and other conditions can be obtained upon application to the Secretary.

No. 348.—A prominent Canadian mining company desires an engineer experienced in underground surveying, draughting, making estimates, etc., the usual duties of an engineer at a mine. Salary $125 to $150 depending on qualifications. Single man preferred.

ENGINEERS AVAILABLE

(Under this heading will be published notes sent to the Secretary of the Institute by members or other persons introduced by members.)

No. 484.—A mining engineer and geologist of long and varied experience in North and South America is open for an engagement. Exploration and development work preferred. Rare minerals a specialty.

No. 485.—Member, mining engineer, technical graduate, married, age 28, exempt, with 9 years experience at gold and silver, copper, lead, and coal mines, 4 years with present employers, is open for engagement as mine superintendent or foreman, or in charge of cyanide plant. Boston or New York interview after Oct. 10. Present position, day foreman at producing gold-silver mine in Montana. References.

No. 486.—Member, age 34, married, varied experience in iron, copper, nickel, talc, etc., principally as surveyor, mine and surface geologist, and superintendent of explorations, is open for engagement. Preference, connection with some eastern consulting engineer or firm of engineers.

No. 487.—Member, mine superintendent, 18 years' experience in the West and in the Lake Superior districts. Thorough business and technical training. Personal interview, preferably Chicago.

No. 488.—Mining engineer, member, technical graduate, married, age 38, desires position of superintendent or assistant superintendent. Has had 15 years' practical experience as miner, millman, machinist, surveyor, engineer, foreman, and superintendent in the West, Southwest, and Mexico. Speaks Spanish. Now employed as superintendent of copper property in Southwest. Can give the best of references. Minimum salary $250. Available after Sept. 1.

No. 489.—Experienced mining engineer now in responsible position in South America desires change to United States or other favorable locality. Successful experience in management of mining and metallurgical enterprises.

No. 490.—Member, technical graduate, age 38, married, desires position as manager or superintendent. Experience covers 14 years of mining, cyaniding, concentration, flotation, etc., with 8 years in administrative positions. Fluent Spanish; references. Employed at present.

LIBRARY

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF MINING ENGINEERS
UNITED ENGINEERING SOCIETY
HARRISON W. CRAVER, DIRECTOR

The library of the above-named Societies is open from 9 A.M. to 10 P. M. except on holidays. It contains about 70,000 volumes and 90,000 pamphlets, including sets of technical periodicals and publications of scientific and technical societies.

Members of the Institute, with few exceptions, are forced to spend a portion of their time in localities isolated from sources of information. To these the Library, through its Library Service Bureau, can render valuable service through correspondence; letters requesting information will receive especial attention. The Library is prepared to furnish references and photographic copies of articles on mining and metallurgical subjects; to determine the existence of mining maps, and to furnish general information on the geology and mineral resources of all countries.

All communications should be made as definite as possible so that the information received may be what is desired and not include collateral matter which may not be of interest. The time spent in searching for such collateral matter will be saved, and the information will be sent more promptly and in more usable shape.

Library Accessions

ALABAMA. Coal Mines. Annual Report. 1917. Birmingham, 1917. (Gift of Chief Mine Inspector.)

AMERICAN ELECTROCHEMICAL SOCIETY TRANSACTIONS. Vol. 32. Bethlehem, Pa., 1918.

AMERICAN WOOD PRESERVERS' ASSOCIATION. Report of Proceedings 14th Annual Meeting, 1918. (Gift of Association.)

BLASTERS' HANDBOOK. Wilmington, 1918. (Gift of E. I. du Pont de Nemours & Co.)

BRAZIL. Ministerio da Agricultura, Industria & Commercio. Boletim do. Anno V, No. 1. Rio de Janeiro, 1916. Geologia. Annexo No. 1. Rio de Janeiro, 1915. Monographias. Volume I. Rio de Janeiro, 1913. Regiões carboniferas dos Estados do Sul pelo Geologo Euzebio Paulo de Oliveira, 1918. Servico Geologico e Mineralogico do Brasil. Rio de Janeiro, 1916.

CANADA, MINERAL PRODUCTION OF, DURING THE CALENDAR YEAR 14th Annual Report. Ottawa, 1918.

CONCRETE CONSTRUCTION, ARTICLES ON. Portland Cement Association, Magazine list, May, 1918. (Gift of Association.)

FRENCH-ENGLISH MILITARY TECHNICAL DICTIONARY, WITH A SUPPLEMENT CONTAINING RECENT MILITARY AND TECHNICAL TERMS. By C. DeWitt Willcox. New York, 1917.

FUEL FACTS. August 1, 1918. (Gift of U. S. Fuel Administration.)

GREAT BRITAIN. Department of Scientific and Industrial Research. Report on the sources and production of iron and other metalliferous ores used in the iron and steel industry. London, 1918.

———, Report of the Committee of the Privy Council, 1915–16, 1916–17. London, 1916, 1917.

———, Report of the fuel research board on their scheme of research and on the establishment of a fuel research station. London, 1917.

———, Industrial research in the United States of America. (Science and Industry, No. 1.) London, 1917. (Gift of Great Britain Department of Scientific and Industrial Research.)

INSTITUTE OF METALS. Journal, vol. XIX, No. 1. London, 1918.
LIMES, HYDRAULIC CEMENTS AND MORTARS, PRACTICAL TREATISE ON. By Q. A. Gillmore. New York, 1863. (Gift of John T. Whistler.)
MAXIMUM BASE PRICES DIFFERENTIALS AND EXTRAS ON IRON, STEEL AND NON-FERROUS PRODUCTS, FIXED DIRECT BY THE GOVERNMENT AND THROUGH RECOMMENDATION OF AMERICAN IRON AND STEEL INSTITUTE. Cleveland, 1918. (Gift of Penton Publishing Co.)
METALLURGICAL STUDY OF THE STEEL BASE AS RELATED TO GALVANIZING. By G. A. White. Buffalo. (Gift of Matthews-Northrup Works.)
MINING ENGINEERS' HANDBOOK. By Robert Peele. New York, 1918.
OIL INDUSTRY, THE NECESSITY FOR GOVERNMENT CONTROL OF. By M. L. Requa. Address delivered July 22, 1918. (Gift of U. S. Fuel Administration.)
PROFIT SHARING, ITS PRINCIPLES AND PRACTICE. By A. W. Burritt and others. New York, 1918.
PYRITES DEPOSITS OF GEORGIA, PRELIMINARY REPORT ON A PART OF. (Georgia Geological Survey, *Bulletin* No. 33.) Atlanta, 1918.
RED CROSS INSTITUTE FOR CRIPPLED AND DISABLED MEN. Provision for vocational re-education of disabled soldiers in France. (Publication No. 14.)
———, PROVISION FOR WAR CRIPPLES IN GERMANY. (Publication No. 13.)
———, PROVISION FOR WAR CRIPPLES IN ITALY. (Publication No. 12.) (Gift of Red Cross Institute for Crippled and Disabled Men.)
U. S. TARIFF COMMISSION. Outline of its work and plans. Dec., 1917. Washington, 1917. (Gift of U. S. Tariff Commission.)
WEST VIRGINIA. County Reports. Barbour and Upshur counties and western portion of Randolph County, with maps. Wheeling, 1918.

Book Notices

Unless otherwise specified, books in this list have been presented by the publishers. The Institute does not assume responsibility for any statements made; these are taken from the preface or the text of the book, unless otherwise noted.

BRIDGES. A Handbook for the Use of Those Interested in the Construction of Short-span Bridges. By John W. and Edward D. Storrs, Concord, N. H. (the authors), 1918. 40 illus., 20 tab., 7 × 4 in., flexible cloth, $1.

A small pocketbook containing designs and methods of construction of small highway bridges, culverts, etc. Intended to assist men without engineering training in the construction of such structures.

CHEMICAL CONTROL OF GAS MANUFACTURE. Practical Instruction in Gas Works Chemistry for Superintendents, Foremen and Chemists. Part I. Practical Application. By W. M. Russell. Part II. Elementary Chemical Theory. By F. Wills. N. Y., The Gas Age, 1916. 152 pp., 47 illus., 1 pl., 18 tab., 8 × 5 in., cloth, $1.50.

Devoted to a discussion of the methods for controlling gas works processes by the use of chemistry, giving the most recent and reliable tests and analyses and explaining the methods used. Adapted to the requirements of the men in the smaller plants.

A HANDBOOK OF BRIQUETTING. By G. Franke, trans. by Fred C. A. H. Lantsberry. Vol. II. Briquetting of Ores, Metallurgical Products, Metal Swarf and Similar Materials, Including Agglomeration. Lond., Charles Griffin & Co., Ltd., Phila., J. B. Lippincott Co., 1918. 11 + 214 pp. 79 illus., 4 folded pl., 14 tab., 9 × 6 in., cloth. (Gift of J. B. Lippincott Co.)

Describes the various materials briquetted, methods of briquetting and agglomeration, preparation of material, compression and subsequent treatment of briquets. A number of complete briquetting and agglomeration plants in Germany and Austria shown in detail. Appendices to volumes 1 and 2 are included.

HANDBOOK OF MATHEMATICS FOR ENGINEERS. By Edward V. Huntington, with Tables of Weights and Measures By Louis A. Fischer. Reprint of Sections 1 and 2 of L. S. Mark's "Mechanical Engineers' Handbook." 1st ed. N. Y., McGraw-Hill Book Co., Inc.; London, Hill Pub. Co., Ltd., 1918. 191 pp., illus., tab., 7 × 5 in., flexible cloth. $1.50.

Designed to supply, in compact form, accurate statements of those facts and formulas of pure mathematics which are most likely to be of use to the worker in applied mathematics. Reprinted from Mark's Mechanical Engineers' Handbook.

HYDRAULIC AND PLACER MINING. By Eugene B. Wilson. 3d ed., thoroughly revised. N. Y., John Wiley & Sons., Inc.; Lond., Chapman & Hall, Ltd., 1918. 425 pp., illus., 1 pl., 20 tab., 8 × 5 in., cloth, $3.

The third edition contains much additional information intended to bring the work up abreast of the latest improvements in this industry. The book is designed to appeal not only to those actually engaged in placer mining but also to those who wish to get the latest ideas on the subject.

MUNICIPAL HOUSECLEANING. The Methods and Experiences of American Cities in Collecting and Disposing of their Municipal Wastes—Ashes, Rubbish, Garbage, Manure, Sewage, and Street Refuse. By William Parr Capes and Jeanne Daniels Carpenter, with an introduction by Cornelius F. Burns. N. Y., E. P. Dutton & Co., 1918. 20 + 232 pp., 16 tab. (2 folded) 10 × 6 in., cloth, $6.

Designed to furnish the information needed by those who are interested in the problems of the collection, care and disposal of municipal wastes. Also takes up the need for more efficient management and for the development of revenue-producing by-products. Intended to help public officials in selecting and operating the system best adapted to local conditions, and also to serve as a guide to the layman who wishes to inform himself about the methods of municipal housecleaning.

STEAM ENGINES. A Thorough and Practical Presentation of Modern Steam Engine Practice. By Llewellyn V. Ludy, Chic., American Technical Society, 1917. 192 pp., 103 illus., 1 pl., 8 tab., 8 × 6 in., $1.

Treats of the theory and construction of various types of steam engines, and of their purchase, operation and testing. A non-mathematical treatise intended for stationary engineers and particularly adapted for home study.

WATER RIGHTS DETERMINATION. From an Engineering Standpoint. By Jay M. Whitham. 1st ed. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1918. 12 + 204 pp., tab., 9 × 6 in., cloth, $2 50.

Intended to assist an owner of an indefinite water right in determining the meaning of his right as expressed in horsepowers, and the number of cubic feet of water per second to which he is entitled. Gives citations from representative writings and presents many tests and power determinations used by the author. A bibliography is included.

FORTHCOMING MEETINGS OF SOCIETIES

Organization	Place	Date
		1918
Institute of Metals Division, A. I. M. E.	Milwaukee, Wis.	Oct. 8–11
Iron and Steel Members, A. I. M. E.	Milwaukee, Wis.	Oct. 8–10
American Foundrymen's Association	Milwaukee, Wis.	Oct. 7–12
American Museum of Safety and Sanitation, Exposition	St. Louis, Mo.	Oct. 7–12
National Safety Council	St. Louis, Mo.	Oct. 14–17
Business Show	New York, N. Y.	Oct. 21–26
National Society of Naval Architects	New York, N. Y.	Nov. 14–15
American Society of Mechanical Engineers	New York, N. Y.	Dec. 3–6
Geological Society of America	Boston, Mass.	Dec. 28–31
American Association for the Advancement of Science	Boston, Mass.	Dec. 27–Jan. 2.
		1919
American Society of Civil Engineers	New York, N. Y.	Jan. 15–16
American Wood Preservers Association	St. Louis, Mo.	Jan. 28–30
American Society of Heating and Ventilating Engineers	New York, N. Y.	Jan. 28–30
American Institute of Mining Engineers	New York, N. Y.	Feb. 17–20
New England Association of Gas Engineers	Boston, Mass.	Feb. 19
American Railway Engineering Association	Chicago, Ill.	Mch. 18–20

MEMBERSHIP

NEW MEMBERS

The following list comprises the names of those persons who became members during the period Aug. 10, 1918, to Sept. 10, 1918.

BATCHELOR, HARRY D., Laboratory Director, National Carbon Co., Inc., Cleveland, Ohio.
BROWNING, C. P., Gen'l Supt., Britannia Min. & Smelt. Co., Ltd., Britannia Beach, B. C., Canada.
COMSTOCK, GEORGE F., Met., Chg. of Physical Test Laboratory, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
CONCKLIN, BERT M. ....Chief Engr., Arthur Iron Min. Co., Hibbing, Minn.
COWAN, W. A., Asst. Chief Chem., National Lead Co., 129 York St., Brooklyn, N. Y.
DAVIDSON, PHILIP ....Met., Scovill Mfg. Co., Waterbury, Conn.
DAVIS, LOUIS L., Mgr. & Treas., Commonwealth Min. Co., 911 Foster Bldg., Denver, Colo.
DAY, P. W. ....Chem. Engr., Western Cartridge Co., 207 E. 12th St., Alton, Ill.
DECKER, HAROLD DEWITT, Co. A, 27th Engineers, A. P. O. 714, A. E. F., Care Postmaster, N. Y.
DELONG, BERTON HENRY...........Asst. Met., Carpenter Steel Co., Reading, Pa.
DITTMANN, REHFUSS............Asst. Met., American Bronze Corpn., Berwyn, Pa.
EMERSON, HARRINGTON......Pres., Emerson Co., 30 Church Street, New York, N. Y.
EVANS, HARRY J...........Engr., Oriental Cons. Min. Co., Unsan, Chosen, Korea.
FEAR, THOMAS G...........Gen'l Supt., Inland Collieries Co., Harmarville, Pa.
FORD, ALLEN P............................Met., Crane Co., Bridgeport, Conn.
FOWLER, HAROLD W., Gen'l Mgr., Cia. de Minas La Blanca y Anexas, S. A., Pachuca, Estado de Hidalgo, Mexico.
FRANK, WILLIAM K., Vice-Pres. & Gen'l Mgr., Damascus Bronze Co., Pittsburgh, Pa.
FRANKLIN, NELSON..........Min. & Met. Mgr., 603 Symes Bldg., Denver, Colo.
FROHMAN, E. D., Vice-Pres., The S. Obermayer Co., 2835 Smallman St., Pittsburgh, Pa.
FRY, ALFRED T., Asst. Met., Mt. Lyell Min. & Railway Co., Ltd., Queenstown, Tasmania.
GLINES, CHARLES H., JR.......Chief Engr., Squibbs Laboratory, Brooklyn, N. Y.
HALL, LOUIS J., Pres. & Gen'l Mgr., Columbian Bronze Corpn., 50 Church St., New York, N. Y.
HARDER, OSCAR E........Research Chem., The N. K. Fairbank Co., Chicago, Ill.
HOGABOOM, GEORGE B., Research Electro-plater, U. S. Bureau of Standards, Washington, D. C.
HORTA BARBOSA, F. B......Rua Theophilo Ottoni No. 92, Rio de Janeiro, Brazil.
LEE, JOSEPH H....Prop., Providence Brass & Aluminum Foundry, Providence, R. I.
LOTHROP, M. T............Asst. Mgr., Timken Roller Bearing Co., Canton, Ohio.
MANDERFIELD, EDWARD A., Supt., Refugio Mine, Cia. de Minerales y Metales, S. A., Cerralvo, Nuevo Leon, Mexico.
MARTIN, W. C., Chief Chem., Chicago Bearing Metal Co., 2234 West 43d St. Chicago, Ill.
MAYREIS, LOUIS JOHN, Min. Engr. & Met.; Asst. Resident Mgr., Burma Mines, Ltd., Namtu, Burma.
MERICA, PAUL D............. Met., U. S. Bureau of Standards, Washington, D. C.
MITCHELL, W. G.......Min. Engr., R. Martens & Co., 24 State St., New York, N. Y.
MORRISON, RICHARD C., Gen'l Supt., Vanadium Dept., Primos Chemical Co., Vanadium, San Miguel Co., Colo.
MOUSSETTE, O. J...........................22-26 Clay St., Brooklyn, N. Y.
MOWREY, W. E., Assayer, Refiner & Met...1435 University Ave., St. Paul, Minn.
NEIMAN, F. J...............Supt., Locust Mountain Coal Co., Shenandoah, Pa.
PARR, S. W.........Prof. of Applied Chem., University of Illinois, Urbana, Ill.
PATCH, N. K. B.........Sec'y & Wks. Mgr., Lumen Bearing Co., Buffalo, N. Y.
PATRICK, ROBERT A., Sec'y & Plant Mgr., Columbian Bronze Corpn., Freeport, N. Y.
PRICE, WILLIAM B......Chief Chem. and Met., Scovill Mfg. Co., Waterbury, Conn.
QUIGLEY, W. S., Pres., Quigley Furnace Specialties Co., Inc., 26 Cortlandt St., New York, N. Y.

RAPP, F. A., Supt., Whitney-Lass Chrome Mines, Claim Point, Seldovia, Alaska.
REGNELL, RALPH T., Supt. of Development, Hollinger Cons. Gold Mines, Ltd., Box 668, Timmins, Ont., Canada.
RITTER, HENRY..................Supt., Lunkenheimer Co., Cincinnati, Ohio.
ROBERTSON, ALMON FULTON, Min. Engr.; U. S. Mineral Surveyor, 2411 Harvard Ave., Butte, Mont.
ROGERS, OLA J., Oil Producer and Geol........................Cleveland, Okla.
SCANLON, W. L., Min. Engr. and Geol., The Mond Nickel Co., Ltd., Garson Mine, Ont., Canada.
SHELLSHEAR, WILTON, Care L. J. Griffiths, Esq., Broken Hill Proprietary Co., Newcastle, New South Wales, Australia.
SKILLMAN, VERNE, Met., General Aluminium & Brass Mfg. Co., E. Grand Blvd. & St. Aubin Ave., Detroit, Mich.
SMITH, W. H.......................Met., American Bronze Corpn., Berwyn, Pa.
STRANG, ELMORE S., Chem. Engr. and Met., Baltimore Tube Co., Inc., Baltimore, Md.
THURMOND, F. LEROI.................Anchorage Assay Office, Anchorage, Alaska.
TONE, FRANK J........Works Mgr., The Carborundum Co., Niagara Falls, N. Y.
TORELL, TORGNY.........Mgr., Aktiebolaget Elektrolytverken, Vasteras, Sweden.
WALKER, ALBERT S., Industrial Engr., William T. Donnelly, 17 Battery Place, New York, N. Y.
WETTRICK, FREDERICK J.....Min. Engr. and U. S. Mineral Surveyor, Juneau, Alaska.
WILSON, JOSEPH M., Asst. Inspector, Engineering Material, U. S. N., 1243 Russell St. Allentown, Pa,
WOLF, FRED L.....Chem. Engr.; Mfg. Engr., The Ohio Brass Co., Mansfield, Ohio.
WOOD, R. A............Rolling Mill Supt., New Jersey Zinc Co., Palmerton, Pa.

Associates

BACKERT, A. O., Vice-Pres. and Gen'l Mgr., Penton Publishing Co., Cleveland, Ohio.
BLARDONE, GEORGE, Petroleum Statistician, Boyle Publications, Apartado 489, Tampico, Tamps, Mexico.
BRAZIER, JOHN B., Vice-Pres. and Gen'l Mgr., Powhatan Brass & Iron Wks., Ranson, W. Va.
CADMAN, A. M., Sec'y and Treas., A. W. Cadman Mfg. Co., 2816 Smallman St., Pittsburgh, Pa.
CONDIT, JOHN A., District Representative, Joseph Dixon Crucible Co., 409 Erie County Bank Bldg., Buffalo, N. Y.
COOLEY, JAMES W., Purchasing Agent, National Meter Co., 299 Broadway, New York, N. Y.
HAGGENJOS, JOHN, Vice-Pres., Eureka Brass Co., 601 Red Bud Ave., St. Louis, Mo.
MCCLOUD, L. C...Tonopah, Nev.
MELBROD, JOHN G., Foundry Foreman, Titanium Bronze Co., Niagara Falls, N. Y.
OBERDORFER, JONAS L., Mgr., M. L. Oberdorfer Brass Co., 804 E. Water St., Syracuse, N. Y.
PIEL, CARL W., Sec'y, Pioneer Brass Works, 418–424 S. Pennsylvania St., Indianapolis, Ind.
ROBERTS, WALLACE T., District Mgr., Sullivan Machinery Co., 837 Equitable Bldg., Denver, Colo.
SCHNEIDER, LOUIS, Prop., Terre Haute Bronze & Brass Foundry, 1114 Sycamore St., Terre Haute, Ind.
SHOUDY, LOYAL A..............Chief Surgeon, Bethlehem Steel Co., Bethlehem, Pa.
WELLS, SAMUEL WEBSTER........Pet. Geol., Roxana Petroleum Co., Tulsa, Okla.
WHITE, WILLIAM C., Min. Engr., Weedon Min. Co., Ltd., Weedon, Quebec, Canada.

Junior Associates

BERKOVITZ, SAM..............Student, Colorado School of Mines, Golden, Colo.
BIANCHI, ALFRED P.... .... ..Student, Colorado School of Mines, Golden, Colo.
DONALD, ROBERT TASKER...........Corp., 319th Engineers, Camp Fremont, Cal.
DUTTON, DEWEY A.............Student, Colorado School of Mines, Golden, Colo.
JONES, WILLIAM F.........................120 Sherman St., Rock Springs, Wyo.
MARVIN, THEODORE.............Student, Colorado School of Mines, Golden, Colo.
MULFORD, L. D...............Student, Colorado School of Mines, Golden, Colo.
OTTO, JOHN FRANCIS, Min. Engr..................................Hastings, Pa.

ROCKWELL, HARRY M........Student, Michigan College of Mines, Houghton, Mich.
SCHNEIDER, HENRY G......Geol., Metropolitan Exploration Co., Denver, Colo.
SEEMANN, ARTHUR K...........Student, Colorado School of Mines, Golden, Colo.
WHITE, ROGER F., 2d Lieut., Co. D, 4th Engineers Training Regiment, Camp A. A. Humphreys, Va.

Change of Status—Junior Associate to Associate

NOON, T. RODERICK........Asst. to Chief of Min. Dept., Illinois Zinc Co., Peru, Ill.

Total Membership, Sept. 10, 1918..............................7058

CHANGE OF ADDRESS OF MEMBERS

The following changes of address of members have been received at the Secretary's Office during the period Aug. 10, 1918 to Sept. 10, 1918.

This list together with the list published in Bulletins No. 133 to 141, January to September, 1918, and the foregoing list of new members, therefore, supplements the annual list of members corrected to Jan. 1, 1918 and brings it up to the date of Sept. 10, 1918.

ABOUCHAR, S. S., Care Cia. Minerales y Metales, S. A., Santa Eulalia Unit, Apartado 70, Chihuahua, Chih., Mexico.
ADAMS, ARTHUR K................Lieut., Co. 2, E. O. T. S., Camp Humphreys, Va.
ADAMS, L. W...Bethlehem, Pa.
ADDICKS, LAWRENCE.........................6 Church St., New York, N. Y.
ALBERTSON, M. M......McIntyre-Porcupine Mines, Ltd., Schumacher, Ont., Canada.
ALDRICH, HAROLD W., Asst. Gen'l Supt., Inspiration Cons. Copper Co., Inspiration, Ariz.
ALLEN, ARTHUR P.........................Winona Copper Co., Winona, Mich.
ALLEN, C. A...............................General Delivery, Raymond, Wash.
AMIDON, CLAUDE E........11th Training Co., Casual Camp, Camp Cody, N. M.
ANDERSON, AXEL E., Sales Engr., E. I. du Pont de Nemours & Co., 406 Ideal Bldg., Denver, Colo.
APPLIN, PAUL L.......Care Roxana Petroleum Co., Box 82, Mineral Wells, Texas.
BALL, EDWIN MARCOTTEL, Headquarters Co., 51st Infantry, A. E. F., Care Postmaster, N. Y.
BARKE, A. C.........Care U. S. Fuel Co., Kearns Bldg., Salt Lake City, Utah.
BARTON, L. A...........Capt., 604th Engineers, A. E. F., Care Postmaster, N. Y.
BENHAM, WILLARD M., Master Engr., Headquarters Dept., 115th Engineers, A. E. F., via Postmaster, N. Y.
BERNARD, CLINTON P...................34 Harriman Ave., Jamaica, N. Y.
BICKNELL, H. L.....................Co. D, 27th Engineers, Camp Leach, D. C.
BOISE, CHARLES W., Min. Engr......Room 1100, 42 Broadway, New York, N. Y.
BOTSFORD, M. P.......Aetna Explosives Co., Inc., Torrey Bldg., Duluth, Minn.
BRADY, S. H......................Pres., Silver Mines Corpn., Tonopah, Nev.
BROWN, ROBERT L., Ship Draftsman, Tenn. Coal, Iron & Railroad Co., 601 American Trust Bldg., Birmingham, Ala.
BROWN, S. R......................Co. F, 27th Engineers, Camp Leach, D. C.
BROWNING, EDWARD.....1st Engineer Corps, A. E. F., Care Postmaster, N. Y.
BRUNS, C. L., JR.......2d Lieut., Aviation Section, U. S. A., Dorr Field, Arcadia, Fla.
BURFORD, S. W., Capt., Ordnance Supply Div., Rock Island Arsenal, Hotel Blackhawk, Davenport, Ia.
BURG, ROBERT S., 2d Lieut., 5th Reg., 15th Bat., F. A. N. A., A. E. F., Care Postmaster, N. Y.
BURROUGHS, A. H., JR.............Ensign, U. S. Naval Reserve, Bureau of Ordnance.
CANTON, WILLIAM R....Pvt., Headquarters Co., 80th F. A., 7th Division, A. E. F.
CAPLES, RUSSELL B..........Boston & Montana Smelter, Great Falls, Mont.
CARROLL, WALTER..................U. S. Nitrate Plant No. 1, Sheffield, Ala.
CARSTENS, C. E., 2d Lieut., Care Director, Chem. Warfare Service, A. E. F., Care Postmaster, N. Y.
CARTER, EWING.....................R. F. D. 1, Ishkooda Mines, Birmingham, Ala.
CASE, WILLIS WHITTIER, JR., Secretary, Selective Service Board, Division No. 7, Room 203, City Hall, Denver, Colo.

Cavagnaro, David A. .... 336 62d St., Oakland, Cal.
Chase, F. D. .... Apartado 269, Monterey, Mexico.
Chevalier, Jerome A. .... Sun Co., Mineral Wells, Texas.
Clement, Harrison E., Gen'l Mgr., American Min. & Exploration Co., Imlay, Nev.
Colburn, C. Lorimer, Capt., Engineers' Officers' Training School, Camp Humphreys.
Craig, John J. .... 2d Lieut., 311th Engineers, A. E. F., Care Postmaster, N. Y.
Crockard, Frank H. .... Woodward Iron Co., Woodward, Ala.
Crossette, M. F., U. S. Smelt., Refin. & Min. Exploration Co., Room 329, First National Bank Bldg., Denver, Colo.
Crossfield, J. T. K., Lieut., R. A. F., Care Cox & Co., 110 St. Martins Lane, London, W. C. 2, England.
Crutcher, E. R., Met. Engr., Mt. Read & Roseberry Mines Ltd., Queenstown, Tasmania.
Daniels, Joseph, Care S. E. Junkins Co., Ltd., 309 C. P. R. Station, Vancouver, B. C., Canada.
Davidson, Lyndall P., 2d Lieut., 373d Aero Squadron, A. E. F., Care Postmaster, N. Y.
Del Mar, Algernon .... 1424 Alpha St., Los Angeles, Cal.
Dick-Cleland, A. F. .... Capt., 172d Co., R. E., B. E. F.
Dickman, R. N. .... 170 Bay St., St. Augustine, Fla.
Dickson, James K., N. Y. & Honduras Rosario Min. Co., San Juancito, Honduras, C. A.
Dixon, P. S. .... Supt., Papa-Cobras Manganese Mine, Minas Geraes, Brazil.
Dove, D. R., Co. B, Training Detachment, University of Utah, Salt Lake City, Utah.
Duce, James Terry .... Instructed to hold everything.
Duncan, Dan McLean, 2d Lieut., 312th Engineers, A. E. F., Care Postmaster, N. Y.
Duncan, Gustavus A., Gen'l Mgr., Eldorado-Flagstaff M. & M. Co., Nelson, Nev.
Dye, Robert E. .... Box 253, Haileybury, Ont., Canada.
Eagles, R. H., 2d Lieut., C. W. S., Edgewood Arsenal, Hastings-on-Hudson, N. Y.
Eames, Luther B., Fraser & Chalmers, Ltd., Johannesburg, Transvaal, So. Africa.
Earling, Roy B., 2d Lieut., Headquarters Co., 57th Field Artillery, Camp Bowie, Texas.
Edmondson, H. W. ... Capt. E. R. C., 28th Engineers, A. E. F., Care Postmaster, N. Y.
Eldredge, Robert B. .... 330 E. Cucharras St., Colorado Springs, Colo.
Estabrook, Edward L. .... Midwest Refinery Co., Casper, Wyo.
Fairbairn, Alan J., Forminiere Mission-Kasai, Tshikapa, Belgian Congo, West Africa.
Fernandez, A. C. .... Apartado No. 14, Jimenez, Chih., Mexico.
Ferron, Robert D. .... Care Sociedad National de Mineria, Santiago, Chile.
Feust, Arthur .... 462 E. 138th St., New York, N. Y.
Fisher, Howell T., Room 1028, Marbridge Bldg., 34th St. & 6th Ave., New York, N. Y.
Flynn, Francis N. .... Instructed to hold everything.
Galloway, A. D. R. .... Accra, British West Africa.
Gates, Arthur O., Lieut., U. S. N. R. F., U. S. S. *Marblehead*, Care Postmaster, N. Y.
Gill, James P. .... Rolla, Mo.
Goetter, Fred B., Care Escobosa Burns & Co., San Ignacio, Sinaloa, Mexico.
Grant, Ulysses S., IV, 2d Lieut., Textile Equipment Branch, O. Q. M. G., Room 59, 1800 Virginia Ave., Washington, D. C.
Grasty, J. Sharshall .... Box 458, Charlottesville, Va.
Gravatt, C. Marshall, Lieut., A. S., Sig. R. C., 95th Aero Squadron, First Pursuit Group, A. E. F.
Greenan, J. O. .... Lieut., 27th Engineers, Camp Leach, Washington, D. C.
Grenfell, Donald S., 121 Ambulance Co., 106th Sanitary Train, Camp Wheeler, Ga.
Gunther, C. Godfrey .... 479 Orange St., New Haven, Conn.
Hahn, Albert W., Sec'y Metals Disintegrating Co., Inc., 62 Broadway, New York, N. Y.
Haldane, W. G. .... Antioch, Neb.
Hall, Mortimer L. .... 1592 Park Ave., Bridgeport, Conn.
Harbicht, Harlan C., Lieut., Co. 12, Engineer Training Regt., Camp A. A. Humphreys, Va.
Hatfield, Percy W., Standard Ordnance Corpn., Carbon Place & West Side Ave., Jersey City, N. J.
Henniger, Waldemar F. .... Gulf Production Co., Fort Worth, Tex.
Herman, Hyman, "Eurunderie," 111 Kooyong Rd., Armadale, Victoria, Australia.

HESS, RUSH M., Care Southern Manganese Corpn., Brown-Marx Bldg., Birmingham, Ala.
HIBBERT, ARTHUR, Major, 3d Tunnelling Co., Canadian Engineers, B. E. F., France.
HIGGINS, THOMAS F. ....Care American Smelt. & Refin. Co., Caldera, Chile.
HIGLEY, R. C. ...., Palmer House, Chicago, Ill.
KINSLEY, ARTHUR CARRUTHERS, Capt., Co. D, 115th Engineers, A. E. F., Care Postmaster, N. Y.
HOFIUS, MAX T. ....Belize, British Honduras, C. A.
HOLT, JACOB M. ....Thomas Colliery Co., Shenandoah, Pa.
HOOD, K. K. ....American Zinc, Lead & Smelt. Co., Carterville, Mo.
HOUSER, J. N. ....American Zinc Co. of Tennessee, Mascot, Tenn.
HOWELL, JESSE V., Field Artillery Officers Training School, Camp Taylor, Ky.
HUSSISSIAN, K. L., Pvt., Co. 15th, Depot Brigade 161st, Camp Grant, Ill.
IHLSENG, AXEL O. ....449 West 123d St., New York, N. Y.
JAMES, FLOYD D., Ensign, U. S. N., 10th Regiment, Submarine Unit, Pelham Bay Park, New York.
JOHNSON, G. E. ....International Lead Refin. Co., Box 334, Hammond, Ind.
JORDAN, HAROLD S. ....R. F. D. 1, Box 37, Hayward, Cal.
KENNEDY, JOHN S. ....Instructed to hold everything.
KIRK, CHARLES T. ....Kirk & Hoover, Box 1592, Tulsa, Okla.
KNIFFIN, L. M., U. S. Smelt., Refin. & Min. Co., 55 Congress St., Boston, Mass.
LANDFIELD, J. B. ....Burlingame, Cal.
LEE, HUGH B., Gen'l Supt., Mutual Chemical Co. of Canada, Ltd., Black Lake, Quebec, Canada.
LESNIAK, S. W., American Smelt. & Refin. Co., Reforma, Est. San Juan, via Cuatro Cienegas, Coah., Mexico.
LEWIS, ROBERT S. ....University of Utah, Salt Lake City, Utah.
LINTHICUM, J. F. ....Instructed to hold everything.
LOCKE, AUGUSTUS ....317 Hobart Bldg., San Francisco, Cal.
McCULLOUGH, A. S. ....The Carter Oil Co., Box 597, Denver, Colo.
McCRANEY, O. ....Supt., Belmont Shawmut Min. Co., Shawmut, Cal.
McMASTER, A. T. C. ....75 Hamlet Ave., Woonsocket, R. I.
MACKAY, A. N. ....Trevose, West Byfleet, Surrey, England.
MAHONEY, J. N. ....615 77th St., Brooklyn, N. Y.
MAIER, HERMAN R., Lieut., Engr. R. C., 305th Engineer Train, A. P. O. 756, A. E. F., Care Postmaster, N. Y.
MANESS, ORIE N. ....Co. D, 1st Replacement Engineers, Washington Barracks, D. C.
MARSHALL, STUART B. ....Roanoke, Va.
MASLIN, TOM. ....Care Charles Retallic, 1746 Depot St., Calumet, Mich.
MATSUZAWA, DENTARO, Chief of Producing Dept., Nippon Oil Co., Marunouchi, Tokyo, Japan.
MILTON, M. C. ....Mammoth, Cal.
MOILES, EARLE D. ....1275 Bush Street, San Francisco, Cal.
MOONEY, J. D. ....Capt., 309th Ammunition Train, Camp Sherman, Ohio.
MORROW, JOHN T., Chief Engr., Marlin-Rockwell Loading Co., Agent, Wilmington, Del.
MURPHY, J. F. ....Draper Mine, Calumet, Minn.
NOWLAN, H. H. ....1st Lieut., Balloon Observation Corps, F. A., A. E. F.
NOWLIN, R. A. ....2d Co., E. O. T. S., Camp A. A. Humphreys, Va.
PAGE, E. R., 1st Lieut., Air Service, Military Aeronautics, A. E. F., Care Postmaster, N. Y.
PARSONS, ARTHUR B. ....Met. Engr., Burma Mines, Ltd., Namtu, Burma, India.
PARTANEN, ISAK ......Pvt., Headquarters Co., 213th Engineers, Camp Forrest, Ga.
PEARSON, ALFRED, JR. ....Capt., C. E., U. S. A., Camp Humphreys, Va.
PETERSON, CLARENCE J. ....Care C. L. Severy, 803 Mayo Bldg., Tulsa, Okla.
PHILLIPS, LOUIS ....Villa Nova de Lima, Minas Geraes, Brazil.
PICKETT, C. E. ....2d Lieut., F. A. R. C., A. P. O. 718, A. E. F., France.
PITMAN, S. M. ....125 George St., Providence, R. I.
POULSEN, MAGNUS, Chief Engr., Societe Belge Industrielle et Miniere du Katanga, Nr. 20, rue Berteaux-Dumas, Neuilly s/Seine, France.
PRINCE, ERNEST ....556 University Ave., Boulder, Colo.
PURINGTON, IRVING C. ....Engr., United Verde Copper Co., Clarkdale, Ariz.
PUTNAM, Henry R., Capt., Engr. R. C., General Engineering Depot, Washington, D. C.
RABLING, HAROLD, Act. Corp., 2d Draft Reinforcements, Field Engineers, Australian Imperial Forces.

RATICE, LOUIS....................Q. M. C., Barracks No. 2, Camp Dodge, Iowa.
RAY, HORATIO C.......1st Lieut., Engr. R. C., Co. A, 514th Engineers, A. E. F.
READ, J. BURNS......Capt., Ordnance R. C., Inspection Div., Washington, D. C.
REYNOLDS, HENRY D. G.........................Box 872, Los Angeles, Cal.
RICHARD, LOUIS M.........................919 Venezia Ave., Venice, Cal.
ROBITAILLE, A. EDMOND.........................219 Lynch Bldg., Tulsa, Okla.
ROGERS, ALEXANDER P................Metropolitan Club, Washington, D. C.
ROLKER, CHARLES M.....................21 West 58th St., New York, N. Y.
ROUSH, G. A., Capt., Ord. Dept., U. S. A., Inspection Div., 6th & B. Sts., N. W., Washington, D. C.
RUKARD HURD..............U. S. Bureau of Mines, State Capitol, St. Paul, Minn.
SCHEURER, L. R....Co. D, 1st Replacement Engineers, Washington Barracks, D. C.
SCHILLING, GEORGE W.......................129 Carroll St., Freeport, Ill.
SCHINDLER, DONALD F., 34th Co., M. T. D., Machine Gun Training Center, Camp Hancock, Ga.
SCHLERETH, C. Q., Care Cia. de Minerales y Metales, S. A., Apartado 251, Monterey, N. L., Mexico.
SCHMIDT, R. D., Lieut., 324th Field Artillery, A. E. F., Care Postmaster, N. Y.
SCHMIDT, W. C., Min. Engr., Cons. Arizona Smelt. Co., Bluebell Mine, Mayer, Ariz.
SEARING, OLIVER P........Care Constructing Quartermaster, Camp Shelby, Miss.
SENG, CHAN KEY.............................Box 341, Copperhill, Tenn.
SHEELER, WALTER L..................Catlin Shale Products Co., Elko, Nev.
SHRIVER, ELLSWORTH H., 1st Lieut., Co. C, 27th Engineers, A. E. F., Care Postmaster, N. Y.
SHUTTS, ARTHUR B......................182 N. Franklin St., Wilkes-Barre, Pa.
SIXT, W. M..............................Care E. A. Sixt, West Park, Ohio.
SMALL, HORATIO L., Capt., 32d Provisional Ordnance Depot Co., A. E. F., Care Postmaster, N. Y.
SMITH, LYON...................................1370 Race St., Denver, Colo.
SPENGLER, FREDERICK.........................Instructed to hold everything.
SPERR, J. D.........................4420 Northcote Ave., East Chicago, Ind.
SPILSBURY, PERSIFOR G......................214 O'Neill Bldg., Phoenix, Ariz.
STANFORD, RICHARD B..................2824 Napoleon Ave., New Orleans, La.
STANTON, ROBERT B....................................New Caanan, Conn.
STARBIRD, ROY..........................Pvt., Co. D, 63d Infantry, Presidio, Cal.
STEIN, PAUL......................American Smelt. & Refin. Co., Sasco, Ariz.
STEVEN, HUGH M..............Capt., 7th Battalion, Canadian Engineers, B. E. F.
STIFEL, CARL G..........................2007 Herbert St., St. Louis, Mo.
STRAUB, CHARLES E..........................Box 147, Cincinnati, Ohio.
STRONCK, HUBERT N., Chief of Operations, Kenfield-Lamoreaux Co., 1552 Otis Bldg., Chicago, Ill.
TAPLIN, THOMAS J., JR...............16 Lordship Park, London, N. 16, England.
TEETS, JOHN N., U. S. Naval Training Sta., 15th Reg. Aviation, C. P. O. Barracks, Great Lakes, Ill.
TESCH, T. A., Chief Engr. and Designer, Noorbottens Jarnverks Aktiebolag, Tumba, Sweden.
THOMPSON, A. PERRY...........Cons. Min. Geol., 445 Hanover Ave., Oakland, Cal.
THOMPSON, WARREN D., Care William D. Orcutt, 333 Commonwealth Ave., Boston, Mass.
THOMSON, HENRY N................405 West Adams St., Los Angeles, Cal.
THORNE, WILLIAM E........................131 Locust St., Santa Cruz, Cal.
TICKNER, FRANK W.......Care Frontier Brass Foundry, Niagara Falls, N. Y.
TURNER, A. A...Barstow, Cal.
TYSSOWSKI, JOHN, Major, Q. M. R. C., Care C. B. Parker, Woodward Bldg., 15th & H Sts., N. W., Washington, D. C.
UREN, LESTER, C., Capt., Chemical Warfare Service, A. E. F., Care Postmaster, N. Y.
VARIAN, J. P............................615 Franklin Ave., Palmerton, Pa.
VISEL, C. E.......................Co. 3, E. O. T. S., Camp Humphreys, Va.
WALKER, L. A.............General Engineering Co., Salt Lake City, Utah.
WALLOWER, HERBERT HOOVER, 2d Lieut., Co. B, 29th Engineers, A. P. O. 714, A. E .F.
WARD, A. T..............Co. F, 56th Pioneer Infantry, Camp Wadsworth, S. C.
WARD, MERWIN H......................417 Security Bldg., St. Louis, Mo.
WARFORD, NORMAN L., Powdered Coal Engr., Fuller Engineering Co., Allentown, Pa.
WATERS, A. L................Care Charles E. Richardson, Hong Kong, China.

WENSTROM, OLOF, Bonbright & Co., Shawmut Bank Bldg., 55 Congress St., Boston, Mass.
WESTERVELT, E. W. . . . . .Instructed to hold everything.
WILLIS, CHARLES F., Cons. Supervisor, Dept. of Industrial Relations, Phelps Dodge Corpn., Bisbee, Ariz.
WOOD, ROY U., Ensign, U. S. N. R. F., Section R, Bureau of Ordnance, Navy Dept., Washington, D. C.
WORMSER, FELIX E. . . . . .Co. 3, E. O. T. C., Camp Humphreys, Va.
WRAITH, WILLIAM. . . . . .Room 1927, 42 Broadway, New York, N. Y.
WYLER, JOSEPH A. . . . . .1947 West 100th St., Cleveland, Ohio.
YOST, HAROLD K., Asst. Geol., Phelps Dodge Corpn., Burro Mountain Branch, Tyrone, N. M.
YOUNG, LEWIS E. .400 Union Electric Bldg., St. Louis, Mo.
YUNDT, LEONARD D. . . . . . . .Co. A, 27th Engineers, A. E. F., Care Postmaster, N. Y.

MEMBERS' ADDRESSES WANTED

Name. Last address of Record from which Mail has been returned.

ANDERSON, F. B. .Copper Queen Cons. Min. Co., Bisbee, Ariz.
ARMSTRONG, CLIFTON T. . . . . .347 Manhattan Ave., New York, N. Y.
ASHMORE, E. P. .504 Sherbourne St., Toronto, Ont., Canada.
BARNARD, C. W. . . . . .North Chicago Hospital, 2551 N. Clark St., Chicago, Ill.
BARNETT, WILLIAM J. . . .8 Waterloo Place, Pall Mall, London, S. W., England.
BIRD, FRANK H. . . . . .Butler Hotel, Seattle, Wash.
BLANCHARD, RALPH C. .3 Lombard St., London, England.
BOAS, ROSS H. . . . . .Highland Boy Mine, Bingham Canyon, Utah.
BREEDING, F. O. . . . . .Eden Min. Co., Bluefields, Nicaragua.
BROOKE, LIONEL. .Minas del Tajo, Rosario, Sin., Mexico.
BROWNE, ARTHUR B. . . . . .Malleable Iron Fittings Co., Branford, Conn.
BRYANT, GEORGE W. .Apartado 86, Guanajuato, Gto., Mex.
BYERS, WHEATON B. . . . . .50 Hampton Hall, Cambridge, Mass.
CONOVER, M. J. . . . . .Hotel Bellevue, San Francisco, Cal.
DENNIS, PAUL J. . . . . .Bisbee, Ariz.
DETERT, WILLIAM F. . . . . .Jackson, Amador Co., Cal.
EHLERS, L. W. . . . . .2137 St. Louis Ave., St. Louis, Mo.
DEFARIA, C. C., Fiscal das Estradas, Rua Condo do Bomfim, No. 46, Rio de Janeiro, Brazil.
FIELDING, SIR CHARLES. . . . . .Belmont, Faversham, Kent, England.
GEIB, FRANCIS HODGSON. . . . . .Rolla, Mo.
GOLDSMITH, OSHER. . . . . .Rolla, Mo.
HERR, J. CAMPBELL. . . . . .Box 556, State College, Pa.
HOVLAND, HENRY B. . . . . .Los Angeles Athletic Club, Los Angeles, Cal.
KAY, DAVID NELSON. .Ray Cons. Copper Co., Hayden, Ariz.
KERNAN, THOMAS H., School of Mines Experiment Sta., Univ. of Minnesota, Minneapolis, Minn.
KLUGESCHEID, WALTER P. . . . . .616 W. 113th St., New York, N. Y.
KONSELMAN, ALBERT S. . . . . .Globe, Ariz.
LEVY, MILTON M. . . . . .525 Cache la Pouche St., Colorado Springs, Colo.
MORRIS, JOHN M. . . . . .Rolla, Mo.
PRIOR, CHARLES E. . . . . . . .La Blanca y Anexas Mina, Pachuca, Hdgl., Mexico.
ROBERTS, EDWARD J. . .Gen'l Mgr., Nevada Pyramind Min. Co., Riverside Hotel, Reno, Nev.
ROSS, HERBERT W. . . . . .314 Pacific Ave., Piedmont, Oakland, Cal.
SIMPSON, KENNETH M. . . . . .57 Post St., San Francisco, Cal.
STICKNEY, WILLIAM H. . . . . .708 N. Center St., Reno, Nev.
TAO, H. T. . . . . .Rolla, Mo.
TONG, SING KOW. . . . . .404 W. 115th St., New York, N. Y.
VAN RENSSELAER, ARTHUR M. . . . . .119 E. 51st St., New York, N. Y.
WONG, YIN CHARLES. . . . . .Rolla, Mo.
WOO, W. K. . . . . .M 70 Sing Kong Li, Minghong Road, Shanghai, China.

NECROLOGY

(See also "Died in Service.")

The deaths of the following members were reported to the Secretary's office during the month Aug. 10, 1918, to Sept. 10, 1918.

Date of Election.	Name.	Date of Death.
1917	Heine, Bernhardt E.	Aug. 10, 1918.
1918	MacKelvie, N. Bruce	Aug. 1918.

CANDIDATES FOR MEMBERSHIP

APPLICATION FOR MEMBERSHIP.—The Institute desires to extend its privileges to every person to whom it can be of service. On the other hand, it is not desirable that persons should be admitted to membership in classes for which they are not qualified. Members of the Institute can be of great service if they will make a practice of glancing through the list of applicants and promptly notifying the Committee on Membership, or the Secretary of the Institute, of any persons whom they think should not be classified in accordance with the list given.

Applications Lacking Endorsement

Applications for membership have been received from Mr. Braecke and Mr. Wilkie, whose records are given below. These applications lack the necessary number of endorsers, but since these candidates live at some distance from the headquarters of the Institute, their records are published here in order that any members who are acquainted with them may be advised of the circumstances and may have an opportunity of writing to the Secretary endorsing these candidates.

Members

Gustave Braecke, La Carolina, Spain.
Proposed by A. DeDeken.
Born 1860, Nieuport, Belgium. 1886, Grad., School of Mines, Liége, Belgium, M. E. and Engr. of Arts and Manufacturers. 1887–91, Ore-dressing Dept., Humboldt Engng. Works, Kalk, Germany. 1891–1901, Prospecting, Northern Transvaal; Mgr., Molyneux mines, Witwatersrand, Transvaal. 1901–03, Mgr., Gwendoline gold mine, Korea. 1903–06, Mgr., Mina San Vicente, Société La Nouvelle Montagne, Spain. 1906–07, Prospecting for zinc, Djendli mine, Arzelia. 1907–11, Mgr., Ollin mines, North Spain. 1911–13, Reporting in Spain for Société d'Etudes Minière, Brussels. 1914–18, Mgr., Lead mines, Curas and Soldado, and Technical Mgr., New Cerdenillo, Silver-lead mines, La Carolina, Spain.
Present position: Mgr., Société Curas et Soldado de Carolina.

Donald Cook Wilkie, Serembau, Federated Malay States.
Proposed by
Born 1879, Dundee, Scotland. Brothers' school, Penang, Straits Settlements; Baptists' School, Rangoon, Burmah; Donaldson's School, Dundee, Scotland; 1890–92, Wallacetown School, Dundee, Scotland. 1892–98, Mechanical and electrical construction and repair work; engr. experience; drafting room; shop at sea, Ross & Wilkie, Scotland. 1898–99, Asst. Engr., China Borneo Co., Ltd., Sandakan, B. N., Borneo. 1901–03, Salvage Dept., Tangong Pagar Dock Co., Ltd., Singapore. 1903–10, Engr., Pyritical Ore Installation, Sungei Besi recovery of tin stone from arsenical and sulphurous ores, The Straits Trading Co., Ltd., Sungei Besi, Malay States.
Present position—1910 to date: Supt. Engr., Linggi Plantations Ltd.

The following persons have been proposed during the period Aug. 10, 1918, to Sept. 10, 1918, for election as members of the Institute. Their names are published for the information of Members and Associates, from whom the Committee on Membership earnestly invites confidential communications, favorable or unfavorable, concerning these candidates. A sufficient period (varying in the discretion of the Committee, accord-

ing to the residence of the candidate) will be allowed for the reception of such communications, before any action upon these names by the Committee. After the lapse of this period, the Committee will recommend action by the Board of Directors, which has the power of final election.

Members

George Elmer Abernathy, Stoddard, Ariz.
Proposed by S. E. Chaney, Claude Ferguson, W. F. Dietrich.
Born 1885, Springfield, Mo. 1914, Grad., Missouri School of Mines, Rolla, Mo., B. S. in M. E. 1909, Mill work, Utah Copper Co., Bingham Canyon, Utah. 1910–11, Miner; Shift Boss, Leonard mine, Butte, Mont. 1912–14, Supt. of precipitation: Mine Captain, Los Dos Estrellas mine, El Oro, Mex. 1914–15, Asst. in mining, in charge of Laboratory, Missouri School of Mines, Rolla, Mo. 1916, Engr., Arizona Binghamton Copper Co.
Present position—1916 to date: Shift Boss, Arizona Binghamton Copper Co.

William Welsh Adams, San Antonio, Tex.
Proposed by P. K. Lucke, Frank J. Nagel, C. Q. Schlereth.
Born 1887, Sault Ste. Marie, Mich. 1909, Grad., Leland Stanford Univ. 1910–11, Min. Engr., 1911–14, Mine Foreman, Ojuela mines, Durango, Mexico. 1914, Mine Foreman, Sta. Gertrudis mine, Pachuca, Mexico.
Present position—1915 to date: Supt., Paloma y Cabrillas Mines, Higueros, Coah., Mexico.

Jesus Escobar Alvarez, Colombia, S. A.
Proposed by Norman L. Jenks, Juan de la C. Posada, Alejandro Lopez.
Born 1885, Medellin, Colombia. 1902, National School of Mines, Medellin. 1907, Univ. of Antioquia, Medellin; International Correspondence School, Scranton, Pa. 1900–10, Charge of Laboratory, Restreppo & Escobar, Medellin. 1910–11, Mine Mgr., Colombia. 1911–14, Mgr., La. Coscada, Manizales, Colombia. 1914–17, Mine Mgr., El Coral.
Present position—1917 to date: Asst. Mgr., Colombia Min. Co.

Daniel Alexander Barry, Idaho Springs, Colo.
Proposed by Fred. H. Bostwick, Louis S. Noble, Richard A. Parker.
Born 1870, Nova Scotia. Educated at Public Schools. 1894–95, Stationary Engr., Columbia Mines Co., Ward, Colo. 1895, Stationary Engr., Columbia Leasing Co., Ward, Colo. 1896, Tableman, The Big Five Tunnel Ore Reduction & Transportation Co.; Stationary Engr., Modoc Min. & Mill. Co., Ward, Colo. 1897, Night Millman, construction and operation, San Blas Min. Co., Ward, Colo. 1898–99, Night Millman, Santon & Coleman, Lessees, Ward, Colo. 1899–1901, Stationary Engr., Pennsylvania Mill. Co., Boulder, Colo. 1901–04, Stationary Engr., installation and operation of machinery, Big Five Tunnel Ore Reduction &Transportation Co., Frances and Idaho Springs, Colo. 1905–11, Supt., Big Five Tunnel Ore Reduction & Transportation Co., Frances, Colo.
Present position—1911 to date: Supt., Big Five Tunnel Ore Reduction Co. and its successor The Big Five Min. Co.

George Scott Baton, Pittsburgh, Pa.
Proposed by S. A. Taylor, W. W. Keefer, W. A. Luce.
Born 1869, Philadelphia, Pa. 1894, Grad., Lehigh Univ., B. S. 1895, Eng., Monongah Coal & Coke Co., Monongah, W. Va. 1896–1900, Div. Eng., H. C. Frick Coke Co., Scottdale, Pa. 1900–02, Building and operating coal mine, Fayette Co., Pa. 1902–18, Cons. Min. Engr., opening and developing coal properties.
Present position: Member of firm, Baton & Elliott, Civil and Min. Engrs.

Charles Sewell Beach, Frontier, Wyo.
Proposed by W. D. Waltman, W. D. Brennan, P. J. Quealy.
Born 1871, Howell, Mich. 1893, Common and high school. 1895–99, Min. Eng., University of Wyo., B. S.
Present position—1900 to date: Eng. and Asst. Supt., Kemmerer Coal Co.

Theodore Dyer Benjovsky, Sweetwater, Nev.
Proposed by Charles Kirchen, Henry W. Rives, S. H. Brady.
Born 1884, Leadville, Colo. 1909, Grad., Colorado School of Mines, E. M. 1896–1908 (Summers and falls) Min., Silverton, Colo. 1908, With Colorado Geological Survey. 1909–10, Mine Foreman and Supt., W. B. Lowe Min. Co. 1910, Electrician, Vermillion Min. Co. 1910–11, Leasing, La Plata Dist., Colo. 1911–13,

Mgr., ranch at Del Norte, Colo. 1913–14, Gen'l Supt., New State Reduction Co. 1914, Churn drills and field geol., Phelps-Dodge Corpn., Morenci, Ariz. 1914–15, General contracting mining work. 1915–18, Mine Foreman to Cons. Engr., U. S. Gold Corpn. 1918, Mill Foreman, Primos Chemical Co., Empire, Colo.

Present position: Cons. Engr., Nevada Progressive Gold Min. Co.

George Blandy Botsford, Sunrise, Wyo.

Proposed by W. D. Waltman, William F. Moenke, Charles T. Lupton.

Born 1880, Hancock, Mich. 1903, Grad., Michigan College of Mines, Houghton, Mich., B. S. and E. M. 1903–05, Asst. Chem. and Chief Chem., Lake Superior Smelt. Co., Dollar Bay, Mich. 1905, Asst. Min. Eng., Colorado Fuel & Iron Co., Sunrise iron mines. 1905–09, Chief Min. Eng., Colorado Fuel & Iron Co., Div. Eng., Sunrise Branch, Colorado and Wyoming Railroad, Sunrise, Wyo.

Present position—1909 to date: Asst. Supt., Sunrise Mines, Colorado Fuel & Iron Co.

Thomas Albert Brown, Breckenridge, Colo.

Proposed by Fred H. Bostwick, Louis S. Noble, Richard A. Parker.

Born 1861, Yorkshire, England. 1880–84, Placer mining work. 1884–89, Discovered and worked Tip Top, Romance and Salina gold mining properties; engr. and amalgamator, Jumbo Mill, Jumbo Co. 1889–95, Clothing store, Breckenridge, Colo.; mining and reporting; constructed foundry, machine and boiler works, Aspen, Colo. 1895–98, Mined and milled sulphide ores, lead, zinc and iron, Wellington mines, Breckenridge, Colo. 1898, Worked I. X. L. mines, Swan City, Colo. 1899, Supt., Carrie Gold Min. & Mill. Co. 1899–1905, Working own properties, leasing others and reporting on them. 1905, Purchased half interest in I. X. L. properties. 1906–08, Leasing and working Truax mines. 1908–16, Working mining properties.

Present position—1917 to date: Supt., I. X. L. (now Royal Tiger) Mine, Royal Tiger Mines Co.

Ira Clinton Callander, Jodie, W. Va.

Proposed by H. E. Nold, R. H. Morris, George H. Morse.

Born 1888, Ontario, Canada. 1908–14, Ohio State University. 1914–17, Min. Engr., Jasper Park Collieries Ltd., Pocahontas, Alta., Canada. 1917–18, Min. Engr., Gauley Mountain Coal Co., Jodie, W. Va.

Present position: Asst. Supt., Gauley Mountain Coal Co.

Monroe O. Carlson, Namtu, Burma.

Proposed by T. E. Mitchell, Arthur W. Jenks, A. B. Parsons.

Born 1891, Denver, Colo. 1899–1911, Public and high schools, Denver, Colo. 1911–12, Univ. of Denver. 1912–15, Colorado School of Mines, E. M. 1913–15, Sampler, Globe Smelter, Denver, Colo. 1915–16, Engr., Utah Fuel Co., Castle Gate, Utah. 1916–17, Assayer, Chem., Tomboy Gold Min. Co., Telluride, Colo.

Present position—1917 to date: Min. Engr. and Met., Burma Mines Co., Ltd.

Jules Cousin, New York, N. Y.

Proposed by A. E. Wheeler, F. W. Snow, S. H. Ball.

Born 1884, Belgium. 1903–09, Univ. of Liége. 1910, Univ. of Liége and Louvain, M. E., C. E., E. E. 1911–12, Student Engr.; 1912–14, Secretary; 1914–16, Asst. Gen'l Mgr., Union Minière du Haut Katanga (Belgian Congo). 1916–17, Asst. Gen'l Mgr. 1917, Acting Gen'l Mgr., Chemin de fer du Katanga.

Present position—1917 to date: New York Office of Union Minière du Haut Katanga.

Stuart Croasdale, Denver, Colo.

Proposed by Richard A. Parker, H. L. Brown, Webster P. Cary.

Born 1866, Delaware Water Gap, Pa. 1888, B. S.; 1891, M. S. and Ph. D., Lafayette College. 1891–1903, Head Chem., Holden Lixiviation Works, Aspen, Colo. 1893–94, Assayer, Golconda gold mine, Summitville, Colo. 1894–95, Assayer, Gillett Reduction Works, Gillett, Colo. 1895–96, Assaying and investigation, ore treatment, Commonwealth mine, Pearce, Ariz. 1896–1900, Head Chem., Globe Smelt. & Refin. Co., Denver, Colo. Pioneer Smoke Investigation, Anaconda Copper Co., Anaconda, Mont. Development of Burro Mountain Copper Co., N. M. Development of copper leaching process, Ajo, Ariz. Special investigations for American Smelt. & Refin. Co., American Metal Co., U. S. Smelt. & Refin Co., Nipissing Min. Co., and others.

Present position—1900 to date: Cons. Engr., Min., Met. and Industrial Chem.

Mark Orville Danford, Trinidad, Colo.

Proposed by Frank Bulkley, Richard A. Parker, David G. Miller, Louis S. Noble.

Born 1875, New Boston, Ill. Educated at public schools. 1900–06, Asst. Engr.,

Victor Fuel Co. 1906–07, Engr., H. C. Nichols Coal Co. and Chicosa Fuel Co. 1907–11, Senior Member, Danford & Sanderson, Engrs. 1911–14, Gen'l Supt., Cedar Hill Coal & Coke Co. Have acted in consulting capacity for number of coal companies in New Mexico, Utah, Wyoming, Colorado and old Mexico.

Present position—1914 to date: Senior Member, Danford & Douglas, Trinidad; Danford & Thompson, Walsenburg; Danford, Thompson & Douglas, Trinidad and Walsenburg. Cons. Engr., Pikes Peak Fuel Co., Colorado Springs Co., Oakdale Coal Co., Cedar Hill Coal & Coke Co., Crested Butte Anthracite Min. Co., Albuquerque & Curillos Coal Co., Rapson Coal Min. Co. and others.

Oscar Eugene DeWitt, Cuba City, Wis.

Proposed by W. N. Smith, S. H. Davis, Ralph E. Davis.

Born 1885, Susanville, Cal. 1899–1900, Platteville, Wis., Normal School. 1910–12, Platteville, Wis., Mining Trade School. 1909, Coal min., Edmonton, Alberta, Canada. 1911, Zinc mill construction in Wis. 1913, Plant Engr., Rowley mine, Wis. 1914, Asst. Supt., Ellsworth & Rundell mines; Supt., Vinegar Hill mine. 1915, Mill Supt., Martin mine; North Unity mine. 1916, Supt., North Unity mine; Hodge mine. 1917, Supt., Kittoe mine; Jefferson mine.

Present position: Supt., Jefferson Mine, Hazel Green, Wis.

Thomas Bailey Dryer, Birmingham, Alabama.

Proposed by Robert Hamilton, Quin W. Stuart, H. S. Geismer.

Born 1889, Birmingham, Ala. 1908, Grad., Alabama Polytechnic Institute, B. S. 1908, Laborer, electrical construction work, Alabama Polytechnic Institute; draftsman and rodman, Kane Lumber Co. 1909, Draftsman, Thauton Bros., Engrs., Birmingham, Ala.; draftsman, Montgomery Coal Washer & Mfg. Co., Birmingham, Ala. 1909–13, Field Engr., Motley & Dryer, Birmingham, Ala. 1913–17, Min. Engr.; Supt. of Coal Mines, Roden Coal Co., Marvel, Ala. 1917–18, Min. Engr., Tennessee Coal, Iron & Railroad Co., 1918, Construction Engr., Sloss-Sheffield Steel & Iron Co.

Present position: Chief Construction Engr., Sloss-Sheffield Steel & Iron Co.

James Rutherford Elliott, Pittsburgh, Pa.

Proposed by S. A. Taylor, W. W. Keefer, W. A. Luce.

Born 1873, England. 1893, Grad., Western Univ. of Pennsylvania, now Univ. of Pittsburgh, C. E. 1893–1900, Asst. Eng., Wilkins & Davison, Pittsburgh, Pa. 1900–02, Chief Asst., W. G. Wilkins, Pittsburgh, Pa. 1902–07, Member of firm, Elliott & Baton, Pittsburgh, Pa. 1907–16, Min. in Cal., Ariz. and Utah.

Present position—1916 to date: Member of firm, Baton and Elliott, engaged in opening and development of coal min. properties.

Clarence Milton Fenton, Columbus, Ohio.

Proposed by M. S. MacCarthy, Edward L. Blossom, Murray F. Crossette, Harry J. Wolf.

Born 1857, St. Louis, Mo. 1875, Grad., Buffalo High School, Buffalo, N. Y. 1879, Fredonia, N. Y., Academy. 1880–1907, Gen'l Mgr., Erie Preserving Co., Buffalo, N. Y. 1908, Became Dir., Columbus Iron & Steel Co., Columbus, Ohio. 1909, Gen. Supt., coal mines and coking plant, Marting, Fayette Co., W. Va. 1914, Gen'l Mgr., Rising Sun Min. Co., mining zinc ores, Mo. and Ark. 1915, Pres. and Gen'l Mgr., Nevada Smelt. Co., Nevada, Mo. 1915, Sec'y and Dir., Cherokee Smelt. Co., Cherokee, Kan. 1915, Treas. and Gen'l Mgr., American Star Antimony Co., Gillham, Ark. All above companies subsidiary to Columbus Iron & Steel Co. 1917, Vice-Pres., Ohimo Min. Co., Miami, Okla.

Present position—1917 to date: Officer in above six companies.

Edwin Stanton Fickes, Pittsburgh, Pa.

Proposed by H. S. Harrop, S. A. Taylor, W. A. Luce.

Born 1872, Steubenville, Ohio. 1894, Grad., Rensselaer Polytechnic Institute, Troy, N. Y., C. E. 1894–96, Water works construction, in charge construction, coal-min. plant; in charge bridge repairs, etc., Wilkins & Davison, Pittsburgh, Pa. 1896–97, Building mill for National Tube Co.; building bridge over Ohio River, Herman Laub Co., Pittsburgh, Pa. 1897–9, Building coal-min. plant; surveys, sewerage, grading; building water works; Wilkins & Davison, Pittsburgh, Pa. 1899, Designing 96th St. power house and hydro-electric works, F. S. Pearson, New York.

Present position—1899 to date: Chief Engr. in charge of engineering, mining, traffic & purchasing, Aluminum Company of America.

Edgar Harold Gould, White Pine Mine, Mich.

Proposed by Ocha Potter, C. H. Benedict, A. H. Wohlrab.

Born 1887, West Brookfield, Mass. 1907, Grad., Battle Creek High School,

Mich. 1907–8, Univ. of Michigan. 1908–11, Michigan College of Mines, E. M. 1911, Practical timbering, min., Superior Copper Co., Houghton, Mich. 1912, Efficiency Engr. 1913–15, Min. Capt., Osceola Min. Co., Kearsarge, Mich.
Present position—1915 to date: Asst. Supt., White Pine Copper Co.

Richard Jay Gould, Yeager, Ky.
Proposed by H. S. Adkins, H. E. Bullock, E. B. Snider.
Born 1888, Parkersburg, W. Va. 1911, West Virginia Univ., B. S. and E. M. 1911–13, Chief Eng., Brother Valley Coal Co., Macdonaldton, Pa. 1913–15, Asst. Eng., W. G. Wilkins Co., Huntington, W. Va. 1915–17, Chief Eng., Collins interests, Louisville Coal & Coke Co., Bramwell, W. Va.
Present position—1917 to date: Gen. Mgr., Elkhornseam Collieries Co.

Edward Center Groesbeck, Washington, D. C.
Proposed by Henry M. Howe, Bradley Stoughton, John Howe Hall.
Born 1881, Albany, N. Y. 1904, Grad., Williams College, B. A. 1906, Grad., Massachusetts Institute of Technology, S. B. 1909, Williams College, Honorary Degree of M. A. 1906–09, Asst. to Prof. Henry M. Howe in professional and investigation work in iron and steel metallurgy. 1909–11, Devoted largely to study. 1911, Asst., Met. Lab., Taylor Iron & Steel Co. (now Taylor-Wharton Iron & Steel Co.), High Bridge, N. J. 1912–17, Chem.; Met.; Research Asst., Pittsfield (Mass.) Works Laboratory, General Electric Co.
Present position—1917 to date: Asst. to Prof. Henry M. Howe, engaged in research work in iron and steel metallurgy.

Frank E. Grant, Ruth, Nev.
Proposed by R. E. H. Pomeroy, J. C. Kinnear, C. B. Lakenan.
Born 1869, Donner Lake, Cal. 1878–86, Public schools. 1886–89, Locomotive Fireman. 1889–1901, Locomotive Eng. 1901–10, Mgr., hardware business. 1910–18, Supt., steam-shovel operations, Utah Constr. Co., Salt Lake City, Utah.
Present position: Supt., Steam-shovel Mines, Nevada Cons. Copper Co.

Hugo E. Hanser, Muscle Shoals, Ala.
Proposed by W. S. Larsh, Lindsay Duncan, R. E. H. Pomeroy.
Born 1889, Brooklyn, N. Y. 1911, Grad., Univ. of Nevada, B. S. 1911–12, Miscellaneous employment about mines and mills, Tonopah and Goldfield, Nev. 1912, Exploration work, Railroad Valley, Saline Co., Nev.; on engr. staff, Nevada Cons. Copper Co., Ruth, Nev.; Miner, Giroux Cons. Mines Co., Kimberly, Nev. 1912–13, Roaster dept., smelter, Nevada Cons. Copper Co., McGill, Nev. 1913, Engineering, Rochester Dist., Nev.; smelter, Thompson, Nev.; Timberman, Tonopah-Belmont mines, Tonopah, Nev.; leasing and prospecting, southwestern Nev.; admitted to Bar, Nevada Supreme Court. 1914, Timberman, Tonopah-Belmont Mine, Tonopah, Nev.; leasing, Olinghouse Dist., Nev.; with Nevada Engineering Works, Reno, Nev.; prospecting, southern Nevada. 1914–15, Cyanide plant, Aurora Cons. Mines Co., Aurora, Nev. 1915–17, Designing Draftsman, Nevada Cons. Copper Co., McGill, Nev. 1917, Designing Draftsman, Nevada Cons. Copper Co., Ruth, Nev.; Mineral exploration work, Irving, N. Y. 1918, Engr., Const. Dept., Public Service Commission, 1st Dist., New York City.
Present position: Asst. Master Mechanic, Plant No. 2, Air Nitrates Corpn.

Kenneth Conrad Heald, Washington, D. C.
Proposed by David White, Philip S. Smith, F. L. Ransome.
Born 1888, Bennington, N. H. 1907–12, Colorado College, B. S. 1913–14, Yale Univ. 1909–14, Experience in examination of coal and oil lands, U. S. Geol. Survey. 1912, Member, Yale Peruvian Expedition. 1915, Appointed to scientific staff, U. S. Geol. Survey. 1915–18, In charge of oil and gas geologic investigations. Author of report on oil and gas geol. of the Foraker Quadrangle, Okla., *Bull.* 641-B; a report on geologic structure of northwestern part of Pawhuska Quadrangle, Okla., *Bull.* 691-C, and others.
Present position: Associate Geol., U. S. Geological Survey.

Archibald Jones, Pittsburgh, Pa.
Proposed by W. R. Ingalls, A. D. Terrell, Otto Rissmann.
Born 1872, Swansea, Wales. 1891, Grad., Chem., Univ. of Virginia. 1891–1904, Chem., Bertha Zinc Co., Pulaski, Va. 1895–1907, Chem., with Charles Catlett, Staunton, Va.; Virginia Iron and Ry. Co., Goshen, Va. 1897–99, Prospecting in

Ark., built zinc smelt. plant, Sandoval, Ill. 1899–1908, Chem. and Supt., Lanyon Zinc Co., William Lanyon Zinc Co., Prime Western Spelter Co., Iola, Kan. 1908–15, Supt., Bartlesville Zinc Co. and Lanyon Starr Zinc Co., Bartlesville, Okla. 1915–17, Gen'l Mgr., American Zinc & Chemical Co., Langeloth, Pa.

Present position: Met., American Steel & Wire Co.

Fred Jones, Victor, Colo.

Proposed by Thomas B. Crowe, F. L. Smale, L. W. Lennox.

Born 1876, Dallas, Tex. 1900, Grad., Colorado School of Mines, E. M. 1900–03, Surveyor, Stratton Min. & Dev. Co., Victor, Colo. 1903, Surveyed coal lands, ditches and reservoir sites in Colorado. 1903–06, Asst. Surveyor, Portland Gold Min. Co., Victor, Colo. 1906–07, Asst. to J. R. Finlay in examinations. 1907–14, Engr., Portland Gold Min. Co.

Present position—1914 to date: Supt., Portland Mine.

Charles A. Kirtley, Norfolk, Va.

Proposed by William M. Bradley, J. M. Callow, Ernest Gayford.

Born 1883, Jackson, Mich. 1905, Grad., Univ. of Chicago, Ph. B. 1905–07, Assisted S. R. Capps in field work for the "Pleistocene of the Leadville Quadrangle" published by U. S. Geological Survey; Sec'y to Mr. White, Robert Keith Co., Kansas City, Mo. 1907–09, Miner and steam-shovel man, Utah Copper Co., Bingham Cons. Co. and Centennial Co., Eureka, Utah. 1909–13, Various positions in subordinate and full charge of construction work. 1913–14, Asst. Supt. of Construction and Mill Foreman, Gold Mountain mines. 1914–17, Specialty salesman with various houses.

Present position—1917 to date: Oiler, United States Navy.

Kenji Kobayashi, Hokkaido, Japan.

Proposed by M. S. Hachita, A. C. Stahl, John Lloyd.

Born 1873, Nagasaki, Japan. 1902, Grad., School of Mines, Tokyo Univ. 1902–05, Asst. Supt., Mitsui mines.

Present position—1905 to date: Supt., Mitsui Coal Mine, Noborikawa.

Frank Evans Lewis, El Paso, Tex.

Proposed by J. L. Bruce, D. Harrington, Walter E. Burlingame.

Born 1880, Denver, Colo. 1887–97, Public Schools and Manual Training High School, Denver, Colo. 1897–1901, Colorado School of Mines, E. M. 1902–06, Location Engr., Colorado Telephone Co. 1906–07, Sampler, surveyor, assayer and chem., Southwest Smelt. & Refin. Co., Orogrande, N. M. 1907, Sampler, assayer, surveyor, Japan-Flora Co., Telluride, Colo. 1908, Sampler, surveyor, assayer, Tomboy, Atlas and Silver Pick mines, San Juan. 1909–10, Surveying, location work, Central Colorado Power Co. and Denver Reservoir Irrigation Co. 1911, Mill work and amalgamator, Revenue Tunnel Co., Ouray, Colo. 1911–12, Amalgamator and Engr., Liberty Bell Min. Co. 1912–15, Engr. and Acting Mine Supt., Mines Company of America, Mexico. 1916, Examinations, scouting, prospecting, John A. Hassell, Los Angeles, Cal. 1917, Flotation Research Dept., Butte-Superior Co., Butte, Mont. 1917–18, Supt., Aztec mines, Maxwell Land Grant Co.

Present position: Mill designer, David Cole, El Paso.

Ralph A. Meyer, Hill City, S. D.

Proposed by H. D. McCaskey, Harvey S. Mudd, Seeley W. Mudd.

Born 1884, Liverpool, England. 1901–04, Government School of Mines, Cornwall, England, E. M. 1904–05, London Univ., London, England, B. S. 1905–06, Royal School of Mines, Freiberg, Germany. 1908, Associate Member, Royal Society of Arts, London, England. 1906–11, Mine Supt. and Asst. Engr., Nova Scotia mines, Shamrock mine, Kerr Lake mine, Porcupine Success gold mines, Ontario, Canada. 1911–15, Consulting work, El Paso, Tex., covering the States of Chihuahua, Sonora and Durango, Mexico. 1916–17, Consulting work, Los Angeles, Cal. and Oatman, Ariz. 1917–18, Royal Flying Corps, Canada, honorable discharge, May 16, 1918, due to serious accident.

Present position: Cons. Engr., and Engr. in charge, American Tin & Tungsten Co.

Fred Howard Moffit, Washington, D. C.

Proposed by George Otis Smith, Philip S. Smith, David White.

Born 1874, Princeville, Ill. 1895, Grad., Williams College, B. A. 1899, Grad., Lafayette College, Pa., M. A. 1902–03, Columbia Univ., N. Y. 1899–1902, Instructor in mathematics and graphics, Min. Engr. Dept., Lafayette College, Easton,

Pa. 1895–1902 (Summers), Field Asst., U. S. Geol. Survey. 1903–10, Asst. Geol., U. S. Geol. Survey.

Present position—1910 to date: Geol., U. S. Geological Survey, Division of Alaskan Mineral Resources. Have published 25 papers on the geology and mineral resources of Alaska, U. S. Geol. Survey, *Bulletins* 247, 277, 374, 376, 417, 448, 498, 533, 608, 675. Coöperating with Major Bagley in developing a method of mapping by use of photographs taken from airplanes, Topographic Branch, U. S. Geological Survey.

William Bertolette Plank, Urbana, Ill.

Proposed by E. A. Holbrook, F. W. DeWolf, George S. Rice.

Born 1886, Morgantown, Pa. 1908, Pennsylvania State College, B. S.; 1909, E. M. 1908–09, Instr. in mineralogy and geology, Pennsylvania State College. 1909, Transitman, Pennsylvania State Highway Surveys. 1909–11, Engrg. Dept., Philadelphia & Reading Coal & Iron Co., Shamokin, Pa. 1912–16, Engrg. Dept., Pittsburgh Coal Co., Pittsburgh, Pa.

Present position—1916 to date: Min. Eng., U. S. Bureau of Mines.

Ralph Yates Pool, Leadville, Colo.

Proposed by Hugh C. Watson, H. L. Brown, John H. White.

Born 1882, Summers, Ark. 1903, Grad., Univ. of Arkansas. 1903–05, Constr. and operation, G. E. Co., and Metropolitan St. Ry. Co., Kansas City. 1906, Design power plants and apparatus, T. C. Hughes and E. H. Abadie. 1907, Chief Electrician, constr. and operation, U. S. Reclamation Service. 1908, Chief Electrician, constr. and operation, Gold Prince Min. & Mill. Co. 1909–10, Master Mech., South Canon Coal Co., Southern Colo. 1910–15, Chief Electrician, Camp Bird, Ltd. 1916, Constr. and Mine Supt., 30,000 hp. hydro plant, Iron Silver Min. Co.

Present position—1916 to date: Supt., Iron Silver Min. Co.

Edwin Weir Smith, Houston, Tex.

Proposed by R. A. Conkling, John R. Suman, F. B. Plummer.

Born 1890, Denison, Tex. Grad., Texas A. and M. College, B. S. 1909, Topographer, M. O. & G. R. R. Survey. 1910–12, Petroleum Technologist, E. F. Sunnes Co., Gulf Coast Fields. 1912–13, Ch. Engr., Freeport & Mexican Fuel Oil Corpn., Tampico, Mex. 1913–15, Private practice, civ. and pet. engr., Tampico, Mex. 1915, Investigations, Coastal fields. 1915–16, Asst. Engr., Wayson Co., Texas Road Imp. Dist. 1916, Cons. work in Mexico. 1916–17, Cons. work and investigations, California and Mexico. 1917, Asst. Engr. Construction, Camp Logan.

Present position—1917 to date: Asst. Tech. Supt., Texas and Louisiana Division, Roxana Petroleum Co.

William Corbit Spruance, Jr., Washington, D. C.

Proposed by Knox Taylor, Frank L. Connable, W. H. Buell, John H. Hall.

Born 1873, Wilmington, Del. 1890, Friends' School, Wilmington, Del. 1895, Grad., Princeton University, E. E. 1895–96, Shop student, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. 1896–97, Asst. Engr., Wilmington City Electric Co., Wilmington, Del. 1897–1900, Practicing Cons. Engr. 1900–01, Mgr., Cellulose Products Co., Boston, Mass. 1901–03, Cons. Engr., Wilmington, Del. 1903–16, Light, Heat and Power Engr.; manufacture of explosives, Du Pont companies. 1917, Major, Ordnance Dept., U. S. R., duties relating to military powder for U. S. Army, Washington, D. C.

Present position: Lieut.-Col., Ordnance, National Army.

Harry D. Trounce, Camp Humphreys, Va.

Proposed by Horace W. Edmondson, George S. Rice, Jay P. Wood.

Born 1885, Cornwall, England. 1894–1904, Christs Hospital, England. 1907–10, Colorado School of Mines. 1910–11, Highway constr. and min., Cal. and S. D. 1911–12, Civil Engrg., private practice, San Diego, Cal. 1912–15, Constr. Eng., reinforced concrete bridges, seawalls, bldgs., etc. 1915–17, 2d Lieut.; 1917, 1st Lieut., Royal Engineers, British Army, in trenches, Flanders, French front.

Present position: Capt., Engineers Reserve Corp.

John Ward Williams, Saltillo, Coah., Mexico.

Proposed by P. K. Lucke, C. Q. Schlereth, E. F. Salisbury.

Born 1882, New York City. New York High School. Private tuition, Columbia. 1902, Miner, Ariz. 1903–04, Miner, Cal. 1904–05, Shift Boss, Darien Gold Min. Co., Panama, C. A. 1906, Miner, Col. and Calif. 1907–08, Foreman, Butters Salvador

mines, Salvador, C. A. 1909–10, Timberman and Shift Boss, various parts, U. S. A. 1910, Foreman, Central Eureka, Cal. 1910–12, Mine Capt., South America Dev. Co., Ecuador, S. A. 1912–15, Mine Foreman, Cia Minera de Penoles, Durango, Mexico. 1915, Concrete Foreman, Lexington Ave Subway. New York.
Present position—1915 to date: District Supt., Cia Minerales y Metales, Zacatecas, Mexico.

Associates

M. Y. Chang, Pittsburgh, Pa.
Proposed by S. L. Goodale, Robert M. Black, Roswell H. Johnson.
Born 1893, Hunan, China. 1918, Univ. of Pittsburgh, M. E. 1917 (1 Mo.), Asst. Chem., Crucible Steel Co. of America.
Present position: Physical Laboratory, Union Switch & Signal Co.

Maurice Donovan Curran, Toledo, Ohio.
Proposed by W. A. Perry, John N. Reese, John E. Perry.
Born 1893, Jobs, O. 1914, Grad., School of Mines, Ohio State Univ., E. M. 1914–15, Learning blast furnace business, Burden Clerk, Foreman, etc. 1915, Asst. Ch. Chem., Youngstown Works.; 1915–16, Ch. Chem. and Supt., Benzol Plant, Youngstown Works; 1916–17, Supt., Benzol Plant, Toledo Works; 1917–18, Asst. Supt., Toledo Works; By-Product Coke Co.
Present position: Supt., Toledo Works, By-Product Coke Co.

Clyde Marshall Ney, Globe, Ariz.
Proposed by D. L. Forrester, Harold S. Duncan, W. G. McBride.
Born 1889, Franklin, Ind. 1912–14, New Mexico School of Mines. 1914–16, Texas School of Mines, M. E. 1916–17, Smelter Foreman, Braden Copper Co., Rancaqua, Chile, S. A. 1917–18, Transitman (Underground), Phelps-Dodge Corpn., Tyrone, N. M.
Present position: Stope Engr., Old Dominion Copper Co.

Nelson Howard Partridge, Denver, Colo.
Proposed by J. A. Porter, Benjamin B. Lawrence, Frank L. Sizer.
Born 1868, Boston, Mass. 1890, Grad., Williams College, A. B. 1893, Went to Cripple Creek, Colo. and during the greater part of the time since have been interested in the business of mining, leasing, investigating properties and acquiring interests in behalf of myself and of societies in Colo., Ariz. and Mexico. 1906–07, Was one of the owners of the Planet mine, Yuma County, Ariz., and except during the summer months had charge of the development work there. My experience has been mainly with the business side of mining and such limited technical knowledge as I may have has been acquired in connection therewith and from reading.
Present position: As above.

Harold Robert Shidel, Bartlesville, Okla.
Proposed by Everett Carpenter, L. C. Snider, Alexander W. McCoy.
Born 1894, Waukesha, Wis. 1915, Grad., Univ. of Utah, Salt Lake City, Utah, B. S. 1915, Min. surveying, Alta, Utah. 1915–16, Mine and mill operation, Col. Wall mill and mine: Jay Gould mine, Bingham, Utah. 1916–18, Field and office geology, Empire Gas & Fuel Co., Bartlesville, Okla.
Present position: Geol., Empire Gas & Fuel Co.

James Sidney Veatch, Denver, Colo.
Proposed by Chester A. Hammill, A. E. Anderson, W. S. Dickson.
Born 1888, Rockport, Ind. 1903, Grammar school, St. Louis, Mo. 1903–07, High School, St. Louis, Mo. 1908, Business course, St. Louis Business College. 1909–17, Sales force, H. W. Johns-Manville Co., Joplin District, Mo. 1917–18, Special tuition in Elect. Engrg.
Present position—1917 to date: Sales Agent, The Ohio Brass Co., Mansfield, Ohio.

George Frederick Vivian, Butte, Mont.
Proposed by Theodore Simons, C. H. Clapp, Joseph P. Lyden.
Born 1895, Butte, Mont. 1917, Grad., Montana State School of Mines, E. M. 1918 (Jan. to April), Private, Co. A, 316th Engrs., Camp Lewis, Wash. 1918 (May to June), Student, Fourth Engineers Reserve Officers Training Corps, Camp Lee, Va.
Present position: Second Lieutenant, Fourth Engineers Training Regiment, National Army.

STANDING COMMITTEES

Executive

SIDNEY J. JENNINGS, *Chairman*

GEORGE D. BARRON
EDWIN LUDLOW
J. E. JOHNSON, JR.
ROBERT M. RAYMOND

Membership

KARL EILERS, *Chairman*

LEWIS W. FRANCIS
LOUIS D. HUNTOON
J. E. JOHNSON, JR.
ARTHUR L. WALKER

Finance

GEORGE D. BARRON, *Chairman*

CHARLES F. RAND
BENJAMIN B. THAYER

Library

E. GYBBON SPILSBURY,[1] *Chairman*

ALEX C. HUMPHREYS[2]
J. H. JANEWAY[4]
GEORGE C. STONE[3]
BRADLEY STOUGHTON

Papers and Publications

BRADLEY STOUGHTON, *Chairman*

EXECUTIVE COMMITTEE

PERCY E. BARBOUR
WILLIAM A. COWAN
H. C. PARMELEE
THOMAS T. READ
JOSEPH W. RICHARDS
GEORGE C. STONE
SAMUEL A. TAYLOR

J. L. W. BIRKINBINE
WILLIAM H. BLAUVELT
H. A. BRASSERT
WILLIAM CAMPBELL
R. M. CATLIN
ALLAN J. CLARK
FREDERICK G. COTTRELL
KARL EILERS
NATHANIEL H. EMMONS
JOHN W. FINCH
CHARLES H. FULTON
F. LYNWOOD GARRISON
ROBERT C. GEMMELL
H. W. GILLETT
CHARLES W. GOODALE
HARRY A. GUESS
R. DAWSON HALL
PHILIP W. HENRY
HEINRICH O. HOFMAN
WALTER E. HOPPER
HENRY M. HOWE
LOUIS D. HUNTOON
J. E. JOHNSON, JR.
WILLIAM KELLY
JAMES F. KEMP
CHARLES K. LEITH
ANTHONY F. LUCAS
EDWARD P. MATHEWSON
HERBERT A. MEGRAW
PAUL D. MERICA
RICHARD MOLDENKE
SEELEY W. MUDD
R. V. NORRIS
EDWARD W. PARKER
NATHANIEL K. B. PATCH
R. M. RAYMOND
ROSSITER W. RAYMOND
ROBERT H. RICHARDS
L. D. RICKETTS
HEINRICH RIES
RENO H. SALES
ALBERT SAUVEUR
HENRY L. SMYTH
A. A. STEVENSON
RALPH H. SWEETSER
GEORGE D. VAN ARSDALE
ARTHUR L. WALKER
ROLLA B. WATSON
HORACE V. WINCHELL
FREDERICK W. WOOD
DWIGHT E. WOODBRIDGE

Nominations

R. V. NORRIS, *Chairman*

WALTER H. ALDRIDGE
WALTER DOUGLAS
D. W. BRUNTON
C. H. MACDOWELL
C. W. WHITLEY

Institute of Metals Division

WILLIAM M. CORSE, *Chairman*
FRED L. WOLF, *Secretary*, Ohio Brass Co., Mansfield, Ohio

EXECUTIVE COMMITTEES OF LOCAL SECTIONS

New York

Meets first Wednesday after first Tuesday of each month.

ALLEN H. ROGERS, *Chairman*
H. C. PARMELEE, *Vice-chairman*
FOREST RUTHERFORD, *Vice-chairman*
W. S. DICKSON, *Secretary*, 71 Broadway, New York, N. Y.
J. E. JOHNSON, JR.
F. T. RUBIDGE
P. G. SPILSBURY

Boston

Meets first Monday of each winter month.

ALFRED C. LANE, *Chairman*
G. A. PACKARD, *Vice-chairman*
E. E. BUGBEE, *Secretary-Treasurer*, Mass. Inst. of Technology, Cambridge, Mass.
R. L. AGASSIZ
FRED W. DENTON

Columbia

Holds four sessions during year. Annual meeting in September or October.

S. S. FOWLER, *Chairman*
J. C. HAAS, *Vice-chairman*
LYNDON K. ARMSTRONG, *Secretary-Treasurer*, 720 Peyton Bldg., Spokane, Wash.
W. H. LINNEY
J. F. McCARTHY

---

[1] Until Feb., 1919. [2] Until Feb., 1920 [3] Until Feb., 1921. [4] Until Feb., 1922.

Puget Sound

Meets second Saturday of each month.

HENRY LANDES, *Chairman* GEORGE E. ROCKEFELLER, *Vice-chairman*
PERCY E. WRIGHT, *Secretary-Treasurer*, 2012 L. C. Smith Bldg., Seattle, Wash.
SIMON H. ASH. CHARLES SIMENSTAD

Southern California

RALPH ARNOLD, *Chairman* WILLIAM F. STAUNTON, *Vice-chairman*
ALVIN B. CARPENTER, *Secretary-Treasurer*, 530 Citizens National Bank Bldg., Los Angeles, Cal.
A. B. W. HODGES LESLIE C. MOTT
C. COLCOCK JONES JAMES W. NEILL

Colorado

CHARLES M. MACNEILL, *Chairman* GEORGE M. TAYLOR, *Vice-chairman*
FRED CARROLL, *Secretary-Treasurer*, State Capitol, Denver, Colo.
W. W. CASE H. E. COLLBRAN

Montana

N. B. BRALY, *Chairman* B. H. DUNSHEE, *Vice-chairman*
E. B. YOUNG, *Secretary-Treasurer*, 526 Hennesy Building, Butte, Mont.
F. W. BACORN C. D. DEMOND

San Francisco

Meets second Tuesday of each month.

A. C. LAWSON, *Chairman* ROY H. ELLIOTT, *Vice-chairman*
W. H. SHOCKLEY, *Secretary-Treasurer*, 959 Waverley St., Palo Alto, Cal.
T. A. RICKARD C. F. TOLMAN, JR.

Pennsylvania Anthracite

R. V. NORRIS, *Chairman*
CHARLES F. HUBER, *Vice-chairman* EDWIN LUDLOW, *Vice-chairman*
W. J. RICHARDS, *Vice-chairman* ARTHUR H. STORRS, *Vice-chairman*
PAUL STERLING, *Secretary-Treasurer*, Lehigh Valley Coal Co., Wilkes-Barre, Pa.
DOUGLAS BUNTING W. W. INGLIS HENRY W. MONTZ
JOHN M. HUMPHREY EDWARD E. KAERCHER ROBERT A. QUIN

St. Louis

EUGENE McAULIFFE, *Chairman* J. N. HOUSER, *Vice-chairman*
VICTOR RAKOWSKY, *Vice-chairman* H. G. WASHBURN, *Vice-chairman*
WALTER E. McCOURT, *Secretary-Treasurer*, Washington Univ., St. Louis, Mo.
H. A. BUEHLER G. H. COX L. C. GLENN
E. A. HOLBROOK W. E. NEWNAM

Chicago

CHARLES H. MACDOWELL, *Chairman* LUTHER V. RICE, *Vice-chairman*
HENRY W. NICHOLS, *Secretary-Treasurer*, Field Museum of Natural History, Chicago, Ill.
ALEXANDER K. HAMILTON G. P. HULST
HENRY P. HOWLAND FREDERICK T. SNYDER

Utah

WILLIAM WRAITH, *Chairman* CECIL FITCH, *Vice-chairman*
F. G. MOSES, *Secretary-Treasurer*, University of Utah, Salt Lake City, Utah.
ERNEST GAYFORD E. R. ZALINSKI

Arizona

L. O. HOWARD, *Chairman*
NORMAN CARMICHAEL, 1*st Vice-chairman* J. C. GREENWAY, 2*d Vice-chairman*
H. L. NORTON, *Secretary-Treasurer*, Globe, Ariz.
L. S. CATES F. W. MACLENNAN R. E. TALLY

Nevada

R. E. H. POMEROY, *Chairman* J. C. JONES, *Vice-chairman*
HENRY M. RIVES, *Secretary-Treasurer*, 210 Reno National Bank Bldg., Reno, Nev.
W. H. BLACKBURN FREDERICK BRADSHAW C. B. LAKENAN
EMMET D. BOYLE J. W. HUTCHINSON WHITMAN SYMMES
JOHN G. KIRCHEN

Mexico

(Instituto Mexicano de Minas y Metalurgia)

VICTOR M. BRASCHI, *Chairman*, Committee on Organisation

Tulsa

ALF. G. HEGGEM, *Chairman* ALEXANDER DEUSSEN, *Vice-chairman*
CHARLES H. TAYLOR, *Vice-chairman*
M. M. VALERIUS, *Junior Vice-chairman* ERASMUS HAWORTH, *Vice-chairman*
JAMES H. GARDNER, *Secretary-Treasurer*, Tulsa, Okla.
IRVING PERRINE J. J. RUTLEDGE S. H. WORRELL

Washington, D. C.

HERBERT C. HOOVER, *Chairman*

H. FOSTER BAIN, *Vice-chairman* DAVID WHITE, *Vice-chairman*

HARVEY S. MUDD, *Secretary-Treasurer*, Room 2114, Dept. of Interior Bldg.

J. F. CALLBREATH HENNEN JENNINGS E. W. PARKER T. T. READ

COMMITTEE ON JUNIOR MEMBERS AND AFFILIATED STUDENT SOCIETIES

CHARLES H. FULTON, *Chairman*

Vice-chairmen

EDWIN C. HOLDEN
GEORGE J. YOUNG
FREDERICK W. SPERR

WALTER R. CRANE, *Secretary*, Pennsylvania State College, State College, Pa.

LUTHER W. BAHNEY
DARSIE C. BARD
ROBERT H. BRADFORD
SAMUEL W. BEYER
GUY H. COX
JOSEPH DANIELS
NOAH F. DRAKE
FRANK W. DURKEE
HOWARD ECKFELDT
DAVID M. FOLSOM
R. R. GOODRICH
CHARLES E. LOCKE
JAMES F. McCLELLAND
HARRY B. MELLER
WALTER S. MORLEY
HENRY S. MUNROE
CHARLES J. NORWOOD
H. C. PARMELEE
GEORGE S. RAYMER
HEINRICH RIES
HENRY L. SMYTH
HARRY H. STOEK
FRANCIS A. THOMSON
CLINTON M. YOUNG

COMMITTEE ON INCREASE OF MEMBERSHIP

J. V. N. DORR, *Chairman*

FOREST RUTHERFORD, *First Vice-chairman*

H. C. PARMELEE, *Secretary, Chem. & Met. Eng.*, 10th Ave. & 36th St., New York, N. Y.

Vice-chairmen

L. K. ARMSTRONG
C. H. BENEDICT
ELI T. CONNER
DORSEY HAGER
G. P. HULST
P. M. McHUGH
H. L. WILLIAMS
DWIGHT E. WOODBRIDGE
R. B. WOODWORTH

Committee

FRANK L. ANTISELL
C. E. ARNOLD
FRANKLIN BACHE
D. C. BARD
LOUIS V. BENDER
SAMUEL W. BEYER
NORMAN B. BRALY
G. S. BROOKS
ALAN BRUYERE
FRANK BULKLEY
FRED CARROLL
THOMAS H. CLAGETT
G. M. COLVOCORESSES
ARTHUR CROWFOOT
H. W. DU BOIS
J. A. EDE
L. V. EMANUEL
NEWTON W. EMMENS
J. N. ESSELSTYN
ERNEST GAYFORD
H. W. HARDINGE
ENOCH HENDERSON
HERBERT B. HENEGAR
FRANK R. HEWITT
JOSEPH T. HILLES
C. B. HOLLIS
T. A. JANNEY
ZAY JEFFRIES
OLAF P. JENKINS
FRANK G. JEWETT
ARTHUR G. JOHNSON
F. F. JORGENSEN
C. B. LAKENAN
LEONARD LARSON
E. T. LEDNUM
CHARLES LEGRAND
EUGENE McAULIFFE
ROBERT McCART, JR.
JOHN H. McCHRYSTAL
W. E. McCOURT
V. H. McNUTT
T. W. MATHER
E. P. MATHEWSON
T. POOLE MAYNARD
H. W. MORSE
HENRY W. NICHOLS
C. C. O'HARRA
FRANK H. PROBERT
JOSEPH W. RICHARDS
OTTO RISSMANN
W. W. ROSE
FRANK L. SIZER
LEWIS STOCKETT
WALTER G. SWART
ARTHUR M. SWARTLEY
ARTHUR F. TAGGART
JOHN C. TAYLOR
WILLIAM D. WALTMAN
JESSE B. WARRINER
E. R. WASH
W. Y. WESTERVELT
F. R. WICKES
BERKELEY WILLIAMS

INSTITUTE REPRESENTATIVES

United Engineering Society Trustees

CHARLES F. RAND[2]
W. L. SAUNDERS[1]
BENJAMIN B. THAYER[1]

Engineering Foundation

R. M. RAYMOND[1]
J. W. RICHARDS
BENJAMIN B. THAYER[1]

Library Board, United Engineering Society

ALEX C. HUMPHREYS[3]
J. H. JANEWAY[4]
BRADLEY STOUGHTON
E. GYBBON SPILSBURY[1]
GEORGE C. STONE[2]

John Fritz Medal Board of Award

C. R. CORNING[2]
CHARLES F. RAND[1]
E. GYBBON SPILSBURY[4]
BENJAMIN B. THAYER[3]

Engineering Council

J. PARKE CHANNING[3]
S. J. JENNINGS[1]
P. N. MOORE[2]
B. B. LAWRENCE[1]
EDWIN LUDLOW[2]

American Association for the Advancement of Science

WALDEMAR LINDGREN
JOSEPH B. TYRRELL

Committee on Standardization of Graphical Methods

JUDD STEWART

Joint Committee on War Minerals

WILLIAM Y. WESTERVELT

Committee on Mining Law Revision

JAMES R. FINLAY
D. C. JACKLING
EDMUND B. KIRBY
HENNEN JENNINGS
C. F. KELLEY

National Research Council

P. N. MOORE

Naval Consulting Board

Members

WILLIAM L. SAUNDERS
BENJAMIN B. THAYER

Associate Members

STEPHEN O. ANDROS
E. J. BABCOCK
H. R. BATCHELLER
PHILIP R. BRADLEY
J. L. BRUCE
D. W. BRUNTON
ALLAN J. CLARK
F. K. COPELAND
B. F. CRESSON, JR.
ROBERT N. DICKMAN
M. M. DUNCAN
T. C. DU PONT
STANLY A. EASTON
W. E. C. EUSTIS
J. R. FORDYCE
FRANK B. GEARHART
J. C. GREENWAY
LAFAYETTE HANCHETT
C. B. HOLLIS
GEORGE P. HULST
FRANK U. HUMBERT
HENNEN JENNINGS
S. W. McCALLIE
A. J. McQUATTERS
C. W. MERRILL
P. N. MOORE
F. W. O'NEIL
WALTER T. PAGE
W. H. PEIRCE
JOSEPH H. PRATT
H. V. WINCHELL
J. C. RALSTON
CHARLES F. RAND
FRANK D. RASH
R. H. RICHARDS
C. S. ROBINSON
WALTER M. SAUNDERS
E. A. SAYRE
H. L. SCAIFE
A. M. SWARTLEY
PRIESTLEY TOULMIN
W. E. TRENT
M. M. VALERIUS
W. D. WALTMAN
I. C. WHITE
ELI WHITNEY

Committee on Engineering Education

JOHN HAYS HAMMOND
HENRY MARION HOWE

Conference Committee on Proposed Adoption of Metric System

GEORGE F. KUNZ
JOSEPH W. RICHARDS

Joseph A. Holmes Safety Association

HENNEN JENNINGS

Joint Conference Committee on American Engineering Standards

J. W. RICHARDS
G. C. STONE
ARTHUR L. WALKER

Joint Committee on Water Power Development

H. HOBART PORTER

Washington Medal Commission of Award

ROBERT W. HUNT[2]
CHARLES H. MACDOWELL[1]

---

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921. [4] Until Feb., 1922.

Pan-American Engineering Committee

WALTER H. ALDRIDGE
FREDERICK K. COPELAND
JOSEPH W. RICHARDS
W. H. LEONARD
P. N. MOORE

Committee on Military Engineering of New York

J. PARKE CHANNING
ARTHUR S. DWIGHT
ALEX C. HUMPHREYS
CHARLES F. RAND
L. D. RICKETTS
WILLIAM L. SAUNDERS
BRADLEY STOUGHTON
WILLIAM H. WILEY

COMMITTEE ADVISORY TO THE U. S. BUREAU OF MINES

ARTHUR F. L. BELL
HENNEN JENNINGS
ALBERT R. LEDOUX
E. W. PARKER
L. D. RICKETTS

Electricity in Mining
WILLIAM KELLY
THOMAS H. LEGGETT
SAMUEL A. TAYLOR

Mine Explosions
H. M. CHANCE
FRANK HAAS
CARL SCHOLZ

Mine Subsidence
JAMES F. KEMP
R. V. NORRIS
CHARLES K. LEITH

COMMITTEE ADVISORY TO THE U. S. BUREAU OF STANDARDS

Copper: F. L. ANTISELL
Lead: ARTHUR S. DWIGHT
Nickel: JOHN F. THOMPSON
Aluminum: JOSEPH W. RICHARDS
Zinc: GEORGE C. STONE

COMMITTEE ADVISORY TO THE U. S. TARIFF COMMISSION

Ferrous Metals
J. E. JOHNSON, JR.
H. D. HIBBARD
RICHARD PETERS, JR.

Non-ferrous Metals
HERMAN GARLICHS
F. LYNWOOD GARRISON
FOREST RUTHERFORD

WAR MINERALS COMMITTEE

WILLIAM YOUNG WESTERVELT, *Chairman*,
Representing A. I. M. E., and M. and M. Soc. of Am.
ALFRED G. WHITE, *Secretary*,
Representing U. S. Bureau of Mines
W. O. HOTCHKISS,
Representing Association of American State Geologists
DAVID WHITE,
Representing U. S. Geological Survey
HARVEY S. MUDD, *Asst. Secretary*

Associate Members from the A. I. M. E.

H. A. BUEHLER
FRED CARROLL
N. F. DRAKE
R. D. GEORGE
E. A. HOLBROOK
EDWIN LUDLOW
S. W. McCALLIE
WILLET G. MILLER
EDMUND NEWTON
H. L. NORTON
WILLIAM C. PHALEN
T. A. RICKARD
CHARLES SIMENSTAD
H. H. STOEK
JOSEPH H. TAYLOR
ARTHUR L. WALKER
THOMAS L. WATSON
E. B. YOUNG

TECHNICAL COMMITTEES

Iron and Steel

JOSEPH W. RICHARDS, *Chairman*, Lehigh Univ., So. Bethlehem, Pa.
J. E. JOHNSON, JR., *Vice-chairman*

SUB-COMMITTEES

IRON ORE

DWIGHT E. WOODBRIDGE, *Chairman*
ERNEST F. BURCHARD
WILLIAM KELLY
CHARLES F. RAND

BLAST FURNACES

H. A. BRASSERT, *Chairman*
WILLIAM H. BLAUVELT
AMBROSE N. DIEHL
RICHARD V. McKAY
JAMES GAYLEY

STEEL WORKS

HENRY D. HIBBARD, *Chairman*
GUILLIAEM AERTSEN
FRANK D. CARNEY
C. F. W. RYS
J. S. UNGER
WILLIAM R. WALKER

MECHANICAL TREATMENT

A. A. STEVENSON, *Chairman*
CHARLES A. BUCK
ROBERT W. HUNT
GEORGE MESTA
FREDERICK W. WOOD

FOUNDRY

RICHARD MOLDENKE, *Chairman*
JOHN H. HALL
ENRIQUE TOUCEDA

CHEMISTRY, PHYSICS, AND METALLOGRAPHY

HERBERT M. BOYLSTON, *Chairman*
WILLIAM CAMPBELL
HENRY M. HOWE
JOHN A. MATHEWS
E. GYBBON SPILSBURY
ALBERT SAUVEUR
LEONARD WALDO
WILLIAM R. WEBSTER

Petroleum and Gas

ANTHONY F. LUCAS, *Chairman*
MARK L. REQUA, *First Vice-chairman*
ISAAC N. KNAPP, *Secretary*
RALPH ARNOLD, *Vice-chairman*
WILLIAM N. BEST, *Vice-chairman*
EDWIN T. DUMBLE, *Vice-chairman*
LEONARD WALDO, *Vice-chairman*
DAVID WHITE, *Vice-chairman*
I. C. WHITE, *Vice-chairman*
JAMES F. KEMP, *Vice-chairman*

ARTHUR F. L. BELL
FREDERICK G. CLAPP
EUGENE COSTE
DAVID T DAY
ALEXANDER DEUSSEN
JOHN R. EDWARDS
JAMES H. GARDNER
DORSEY HAGER
ALFRED G. HEGGEM
L. L. HUTCHISON
EZEQUIEL ORDONEZ
M. M. VALERIUS
CHESTER W. WASHBURNE
HERBERT A. WHEELER
W. E. WRATHER

Coal and Coke

SAMUEL A. TAYLOR, *Chairman*
EDWIN LUDLOW, *Vice-chairman*
FREDERICK W. C. WHYTE, *Vice-chairman*
W. J. RICHARDS, *Vice-chairman*
H. H. STOEK, *Vice-chairman*
WILLIAM E. FOHL, *Secretary*, Farmers' Bank Bldg., Pittsburgh, Pa.

S. B. BELDEN
WILLIAM H. BLAUVELT
H. M. CHANCE
THOMAS H. CLAGETT
ELI T. CONNER
JAMES S. CUNNINGHAM
E. V. D'INVILLIERS
W. W. DUFFIELD
HOWARD N. EAVENSON
CHARLES ENZIAN
WILLIAM A. FORBES
WILLIAM H. GRADY
FRANK HAAS
R. DAWSON HALL
FRANK ALBERT HILL
CHARLES F. HUBER
JAMES ELLWOOD JONES
CHARLES E. KREBS
GEORGE J. KREBS
A. C. LEISENRING
SPENCER R. LOGAN
EUGENE McAULIFFE
CHARLES T. MALCOLMSON
FRANK A. MANLEY
R. V. NORRIS
CHARLES J. NORWOOD
FRANK A. RAY
THOMAS H. O'BRIEN
GEORGE S. RICE
JOHN J. RUTLEDGE
CARL SCHOLZ
JOHN ROY SHARP
T. W. SPRAGUE
ARTHUR H. STORRS
ISRAEL C. WHITE
WILLIAM G. WILKINS
LEWIS L. WILLARD
CLINTON M. YOUNG

Precious and Base Metals

CHARLES W. GOODALE, *Chairman*
ARTHUR L. WALKEAR, *Vice-chairman* ROBERT C. GEMMELL, *Vice-chairman*
DARSIE C. BARD, *Secretary*, Montana State School of Mines, Butte, Mont.

SUB-COMMITTEES

COPPER

EDWARD P. MATHEWSON, *Chairman*

LAWRENCE ADDICKS
W. LAWRENCE AUSTIN
JOHN C. GREENWAY
LAFAYETTE HANCHETT
L. OGILVIE HOWARD
FREDERICK LAIST
C. B. LAKENAN
GEORGE W. METCALFE
L. D. RICKETTS
FOREST RUTHERFORD
GEORGE D. VAN ARSDALE
ARTHUR L. WALKER
ARCHER E. WHEELER
ALBERT E. WIGGIN

GOLD AND SILVER

F. LYNWOOD GARRISON, *Chairman*

F. L. BOSQUI
PHILIP R. BRADLEY
CHARLES BUTTERS
ROBERT C. CANBY
ALLAN J. CLARK
GEORGE H. CLEVENGER
HARRY S. DENNY
JOHN V. N. DORR
CHARLES W. MERRILL
WILLET G. MILLER
CHARLES H. MUNRO
R. M. RAYMOND
WHITMAN SYMMES

LEAD

HEINRICH O. HOFMAN, *Chairman*

C. J. ADAMI
LEONARD S. AUSTIN
WILLIAM BRADEN
ARTHUR S. DWIGHT
KARL EILERS
HERMAN GARLICHS
ERNEST A. HERSAM
G. P. HULST
SIDNEY J. JENNINGS
FRANK M. SMITH
WILLIAM A. SMITH
FREDERIC R. WEEKES
RUSH J. WHITE
C. W. WHITLEY
WILLIAM WRAITH

ZINC

GEORGE C. STONE, *Chairman*

S. E. BRETHERTON
GELASIO CAETANI
C. A. H. DESAULLES
H. W. GEPP
W. McA. JOHNSON
FREDERICK LAIST
DORSEY A. LYON
OTTO RISSMAN
C. E. SIEBENTHAL

MISCELLANEOUS METALS

CHARLES H. FULTON, *Chairman*

SIEGFRIED FISCHER
FRANK L. HESS
ZAY JEFFRIES
ROBERT M. KEENEY
GEORGE A. PACKARD
WALTER M. STEIN
JOSEPH STRUTHERS
WILLIS R. WHITNEY

PLACER DEPOSITS

CHARLES JANIN, *Chairman*

MARK N. ALLING
SIDNEY H. BALL
PIERRE BOUERY
C. C. BRAYTON
NEWTON CLEAVELAND
ROBERT E. CRANSTON
F. LYNWOOD GARRISON
J. J. HAMLYN
W. P. HAMMON
ROSS B. HOFFMANN
HENNEN JENNINGS
E. B. KIMBALL
CHESTER F. LEE
H. L. MEAD
F. L. MORRIS
C. H. MUNRO
WILLIAM S. NOYES
HENRY C. PERKINS
O. B. PERRY

Non-metallic Minerals

HEINRICH RIES, *Chairman*
CHARLES P. BERKEY, *Vice-chairman* GEORGE F. KUNZ, *Vice-chairman*
EDWARD W. PARKER, *Vice-chairman*
WILLIAM C. PHALEN, *Secretary*, U. S. Bureau of Mines, Washington, D. C.

SAMUEL W. BEYER
H. A. BUEHLER
JOHN A. DRESSER
R. D. GEORGE
FRANK L. HESS
F. R. HEWITT
F. C. HOOPER
C. COLCOCK JONES
C. G. MEMMINGER
BENJAMIN L. MILLER
WILLET G. MILLER
JOSEPH HYDE PRATT
KENNETH SEAVER
THOMAS L. WATSON

Mining Geology

JOHN W. FINCH, *Vice-chairman*
L. C. GRATON, *Secretary*, Harvard Geological Museum, Cambridge, Mass.

RALPH ARNOLD
JOHN M. BOUTWELL
H. A. BUEHLER
MARIUS R. CAMPBELL
C. R. CORNING
M. J. ELSING
WILLIAM H. EMMONS
F. LYNWOOD GARRISON
IRA B. JORALEMON
JAMES F. KEMP
HENRY LANDES
ALFRED C. LANE
CHARLES K. LEITH
R. V. NORRIS
ARTHUR NOTMAN
EZEQUIEL ORDONEZ
R. A. F. PENROSE, Jr.
JOSEPH HYDE PRATT
HEINRICH RIES
RENO H. SALES
WILLIAM G. SHARP
HENRY L. SMYTH
JOSIAH E. SPURR
M. E. WADSWORTH

Mining Methods

ROBERT M. CATLIN, *Chairman*
BENJAMIN F. TILLSON, *Secretary*, Franklin Furnace, N. J.

TRUMAN H. ALDRICH, JR.
HANS C. BEHR
R. B. BRINSMADE
DOUGLAS BUNTING
LOUIS S. CATES
CHARLES CATLETT
FRED W. DENTON
STANLY A. EASTON
JAMES R. FINLAY
R. C. GEMMELL
JOHN GILLIE
WILLIAM L. HONNOLD
JAMES E. JOPLING
ROBERT A. KINZIE
HENRY KRUMB
WILLIAM H. LEONARD
HENRY LOUIS
JAMES F. McCLELLAND
SEELEY W. MUDD
JAMES B. RISQUE
MILNOR ROBERTS
OSCAR ROHN
GERALD SHERMAN
HENRY L. SMYTH
BENJAMIN W. VALLAT
RUEL C. WARRINER
SAMUEL D. WARRINER
GEORGE WEIR
DWIGHT E. WOODBRIDGE

Milling Methods

ROBERT H. RICHARDS, *Chairman*
CHARLES E. LOCKE, *Secretary*, Mass. Institute of Technology, Boston, Mass.

EARL S. BARDWELL
H. K. BURCH
CHARLES BUTTERS
GELASIO CAETANI
WILLIAM A. CALDECOTT
JOHN M. CALLOW
CHARLES A. CHASE
DAVID COLE
JOHN V. N. DORR
ARTHUR S. DWIGHT
RUDOLF GAHL
H. A. GUESS
H. C. HOOVER
FREDERICK LAIST
C. B. LAKENAN
W. P. LASS
CHARLES W. MERRILL
HENRY S. MUNROE
E. H. NUTTER
C. Q. PAYNE
JOHN B. PORTER
LEWIS G. ROWAND
E. A. C. SMITH
T. B. STEARNS
WALTER G. SWART
ARTHUR THACHER
A. P. WATT
BULKELEY WELLS
ALBERT E. WIGGIN
GEORGE H. WYMAN, JR.

Mining Law

CORNELIUS F. KELLEY, *Chairman*
JOHN W. FINCH, *Vice-chairman*
CURTIS H. LINDLEY, *Vice-chairman*

ALBERT BURCH
J. MURRAY CLARK
WILL L. CLARK
C. LORIMER COLBURN
COURTENAY DEKALB
CHARLES W. GOODALE
EDWIN O. HOLTER
EDMUND B. KIRBY
MARK L. REQUA
WILLIAM SCALLON
CHARLES H. SHAMEL
FRANK L. SIZER
WALTER H. WILEY
HORACE V. WINCHELL

The Use of Electricity in Mines

WILLIAM KELLY, *Chairman*

FRANCIS O. BLACKWELL
GRAHAM BRIGHT
F. K. COPELAND
OZNI P. HOOD
JOHN LANGTON
CHARLES LEGRAND
FREDERICK W. O'NEIL
STEPHEN H. PITKIN
DAVID B. RUSHMORE
HARRY M. WARREN
GEORGE R. WOOD

Industrial Organization

T. T. READ, *Chairman*

NEWELL G. ALFORD	CHARLES W. GOODALE	CARL SCHOLZ
E. E. BACH	EDWIN HIGGINS	L. A. SHOUDY
F. M. BARNES	R. DAWSON HALL	FRANCIS P. SINN
WILLIAM L. BELL	C. R. HOOK	WILLIAM ALLEN SMITH
W. O. BORCHERDT	HENNEN JENNINGS	BENJAMIN F. TILLSON
PHILIP R. BRADLEY	CORNELIUS B. LAKENAN	W. G. WHILDIN
WILLIAM L. CLARK	JOHN LANGTON	ARTHUR WILLIAMS
GEORGE G. CRAWFORD	A. P. LANZA	H. M. WILSON
H. G. DAVIS	JOHN LLOYD	H. M. WOLFLIN
R. W. DEACON	J. W. PAUL	DWIGHT E. WOODBRIDGE
M. M. DUNCAN	JAMES B. RISQUE	H. I. YOUNG
HOWARD N. EAVENSON	J. C. ROBERTS	
CHARLES T. FAIRBAIRN	BURR A. ROBINSON	

SUB-COMMITTEE ON AMERICANIZATION

HENNEN JENNINGS, *Chairman* CORNELIUS B. LAKENAN JAMES B. RISQUE
(To coöperate with National Americanization Committee)

SUB-COMMITTEE ON CRIPPLES IN INDUSTRY

B. A. ROBINSON, *Chairman* NEWELL G. ALFORD EDWIN HIGGINS
(To coöperate with the Surgeon General, U. S. A., and the Red Cross Institute)

SUB-COMMITTEE ON EDUCATION

E. E. BACH, *Chairman* M. M. DUNCAN J. C. ROBERTS
(To coöperate with National Association of Corporation Schools)

SUB-COMMITTEE ON EMPLOYMENT

H. M. WILSON, *Chairman* WILLIAM L. CLARK WILLIAM ALLEN SMITH
(To coöperate with U. S. Department of Labor)

SUB-COMMITTEE ON HOUSING

C. R. HOOK, *Chairman* JOHN LANGTON W. G. WHILDIN
(To coöperate with National Housing Association, and U. S. Dept. of Labor)

SUB-COMMITTEE ON MENTAL HYGIENE IN INDUSTRY

T. T. READ, *Chairman* F. M. BARNES H. M. WOLFLIN
(To coöperate with National Committee for Mental Hygiene)

SUB-COMMITTEE ON PREVENTION OF ILLNESS

H. I. YOUNG, *Chairman* A. P. LANZA L. A. SHOUDY
(To coöperate with American Public Health Association, etc.)

SUB-COMMITTEE ON SAFETY

B. F. TILLSON, *Chairman* H. G. DAVIS J. W. PAUL
(To coöperate with National Safety Council)

SUB-COMMITTEE ON SOCIAL SURVEYS

C. W. GOODALE, *Chairman* PHILIP R. BRADLEY FRANCIS P. SINN
(To coöperate with Russell Sage Foundation)

COMMITTEE ON ARRANGEMENTS, NEW YORK (118TH) MEETING, 1919

ALLEN H. ROGERS, *Chairman* W. S. DICKSON, *Secretary*

J. E. JOHNSON, JR.	F. T. RUBIDGE	P. G. SPILSBURY
H. C. PARMELEE	FOREST RUTHERFORD	

OFFICERS AND DIRECTORS

For the year ending February, 1919

PRESIDENT

SIDNEY J. JENNINGS, ...NEW YORK, N. Y.

PAST PRESIDENTS

L. D. RICKETTS, ... NEW YORK, N. Y.
PHILIP N. MOORE, ...ST. LOUIS, MO.

FIRST VICE-PRESIDENT

C. W. GOODALE, ...BUTTE, MONT.

TREASURER

GEORGE C. STONE, ... NEW YORK, N. Y.

SECRETARY EMERITUS

ROSSITER W. RAYMOND, ...NEW YORK, N. Y.

SECRETARY

BRADLEY STOUGHTON, ...NEW YORK, N. Y.

VICE-PRESIDENTS

KARL EILERS,[1]	District 0	NEW YORK, N. Y.
JAMES MACNAUGHTON,[1]	District 4	CALUMET, MICH.
CHARLES W. GOODALE,[2]	District 5	BUTTE, MONT.
MARK L. REQUA,[2]	District 6	SAN FRANCISCO, CAL.
HENRY S. DRINKER,[3]	District 2	SO. BETHLEHEM, PA.
ROBERT M. RAYMOND,[3]	District 0	NEW YORK, N. Y.

DIRECTORS

GEORGE D. BARRON,[1]	District 0	NEW YORK, N. Y.
EDWIN LUDLOW,[1]	District 2	LANSFORD, PA.
CHARLES F. RAND,[1]	District 0	NEW YORK, N. Y.
THOMAS B. STEARNS,[1]	District 7	DENVER, COLO.
B. B. THAYER,[1]	District 0	NEW YORK, N. Y.
J. E. JOHNSON, JR.,[2]	District 0	NEW YORK, N. Y.
ALLEN H. ROGERS,[2]	District 1	BOSTON, MASS.
HOWARD N. EAVENSON,[2]	District 9	GARY, W. VA.
J. V. N. DORR,[2]	District 0	NEW YORK, N. Y.
WILLET G. MILLER,[2]	District 11	TORONTO, CANADA.
FREDERICK G. COTTRELL,[3]	District 6	SAN FRANCISCO, CAL.
HENNEN JENNINGS,[3]	District 9	WASHINGTON, D. C.
GEORGE C. STONE,[3]	District 0	NEW YORK, N. Y.
SAMUEL A. TAYLOR,[3]	District 2	PITTSBURGH, PA.
ARTHUR THACHER,[3]	District 3	ST. LOUIS, MO.

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921.

All communications in
AMERICAN INSTI

America

I, ———

residing at ———
(Give an add

to be { *admitted* / *transferred*

of Mining Enginee

I was born a

and am a citizen o

I was educa
(A technical edu
not requisite
membershi

I graduated

———

———

———

If you wish the Institut
the names of at least fiv
quainted. A list of memb

I refer to the

Give the names of at least five Members or Associates.
This information need not be given if three members or associates sign the proposal blank.

R MEMBERSHIP

Constitution

E II

RS

te shall comprise four classes, namely:
iates; 4. Junior Associates.

the privileges of membership, excepting
, and Members and Associates whose
ates, Mexico, and Canada, shall not be
residing within the United States of
ears for dues, shall be entitled to vote in
, as hereinafter provided for, by letter

hose persons who on the third Monday
titute, and in addition thereto, all those
s of Members.

ge and must have had at least six years'
ining, geology, metallurgy or chemistry,
st have held positions of responsibility in

college, approved by the Committee on
to two years' employment, as required

mining, geology, metallurgy or chemistry,
ition of responsibility as specified in the

ntific literary work or in teaching in the
by the Committee on Membership, who
in the active practice of mining, geology,
the time so spent in active practice as
nployment in positions of responsibility,
l seem to the Committee on Membership

nent in positions of responsibility may be
the case of persons who have done notable
gy, or have won distinction by research or
bjects. By investigation or research is
distinct from investigations in literature

opinion of the Committee on Membership
such election or transfer by reason of their
gy, metallurgy, or chemistry.

all students in good standing in engineer-
rees and are nominated by at least three
ructors. A Junior Associate may remain
ing the engineering school, at the end of
a Member or Associate must be passed
If elected he shall pay at that time the
ciate.

lassification of a candidate the Committee
y evidence he desires to present and the
status shall be final.

er, Associate, or Junior Associate must be
mbers or Associates, must be approved by
bed in the By-Laws, and must be elected

*Present position:*______________________________

I agree, if elected, to accept election within four months, and to abide by the Constitution and By-Laws.

*Dated*____________________191 *Signature of Applicant:*____________________
(Applicant will fill in this date)

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age (Minimum)	Length of Active Practice	Responsible Charge of Work
Member....	Professional Mining Engineer, Geologist, Metallurgist or Chemist.	27 years	6 years*	3 years
Associate...	Any one interested in mining, geology, metallurgy, or chemistry.			
Junior Associate..	Engineering student who has not received technical degree.			

* See requirements for membership on reverse page.

(DO NOT FILL THESE BLANKS)

FOR ADMISSION / TRANSFER OF

Received____________________

Bulletin____________________

Elected____________________

Second Notice____________________

Third Notice____________________

Final Notice____________________

The Metallography of Tungsten

Discussion of the paper of ZAY JEFFRIES, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 138, June, 1918, p. 1037.

SIR ROBERT HADFIELD, London, England (written discussion*).—We have in the past known so little about tungsten that an important paper such as Mr. Zay Jeffries contributes is most welcome.

I have not much personal knowledge on the subject except as regards combinations of iron with tungsten. I put forward the results of my research on natural alloys in 1903,[1] and so far as I know the facts there presented still stand.

Singular to say, tungsten added to iron affects the electrical resistance less than any other added element. The following tables taken from research work by myself and Sir William Barrett may be of interest.

TABLE 1.—*Approximate Specific Electrical Resistance of Iron Alloys at Different Percentages of the Added Element*

Alloy of Iron with	Percentage of Added Element				
	1	2	3	4	6
Tungsten..........	15.5	16.5	17.2	18.0	18.5
Nickel............	19.0	21.0	23.0	25.0	27.0
Chromium..........	....	....	24.0	26.5	29.0
Manganese.........	23.5	28.0	31.0	34.0	39.0
Silicon...........	....	....	46.0	53.5	69.0
Aluminium.........	27.0	38.0	48.0	57.0	74.0

TABLE 2.—*Increase in Specific Electrical Resistance (Microhms per Cubic Centimeter at* 18° C.) *Produced in Iron of Corresponding Purity by Alloying It with Various Percentages of the Elements Named*

Alloy of Iron with	2 Per Cent.	4 Per Cent.	6 Per Cent.
Tungsten..............................	4.0	5.5	6.0
Nickel................................	6.5	10.0	12.5
Chromium..............................	....	12.0	14.0
Manganese.............................	15.0	21.0	26.0
Silicon...............................	....	41.0	55.5
Aluminium.............................	25.5	44.5	61.5

* Received Aug. 13, 1918.

[1] *Jour.* Iron and Steel Inst. (No. II, 1903), **64**, 14.

The following is the summing up of our results: Selecting the middle column of figures and dividing it by 4, we get the increase of resistance produced by the addition of 1 per cent. of the element in an alloy containing about 4 per cent. of the added element. This is shown in the next table, and side by side are shown the specific heat and the atomic weight of the elements named in the first column.

TABLE 3

Iron Alloyed with	Specific Resistance of 1 Per Cent.	Specific Heat	Atomic Weight
Tungsten	1.1	0.035	184
Cobalt	2.2	0.107	59
Nickel	2.5	0.109	59
Chromium	3.0	0.1(?)	52
Manganese	5.2	0.122	55
Silicon	10.3	0.183	28
Aluminium	11.1	0.212	27

Electrolytic Zinc

Discussion of the paper of C. A. HANSEN, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, p. 615.

J. L. McK. YARDLEY,* Pittsburgh, Pa. (written discussion†).—It is interesting to observe how closely Mr. Hansen agrees with other investigators to the effect that the art of electrolytic zinc has left the realm of mystery. In his introduction, he has said practically what Thomas French said in his paper "The Future of Electrolytic Zinc."[1]

The successful electrolysis of zinc from sulphate solutions has not been an easy matter, and it is only within recent years that the difficult problem of depositing high-grade zinc has been satisfactorily accomplished on a commercial basis. The principal requisite is that the electrolyte shall be quite free from certain impurities. The methods by which freedom from these impurities is assured are now very well understood, and with experienced superintendents there is little difficulty in obtaining a high efficiency in that part of the process.

When certain underlying principles are recognized, the difficulty encountered in dealing with the filtration of the acid and slimy solutions also largely disappears, although it has been a very serious one to the uninitiated. In the dissolving of the zinc from the roasted ore, there is nothing which any competent chemical engineer cannot undertake, and any other operations connected with the electrolytic process are either of little or no difficulty, or are common to the retort process.

Mr. Hansen also agrees with R. G. Hall's statement in "Some Economic Factors in the Production of Electrolytic Zinc:"[2]

* Gen. Engr., Westinghouse Electric and Manufacturing Co.

† Received Aug. 10, 1918.

[1] *Trans.* Am. Electrochem. Soc. (1917), **32**, 321.

[2] *Bull.* 129 (Sept., 1917), 1294. *Trans.* (1918), **57**, 709.

The requirement, and I use it in the singular, for the electrolysis of zinc is zinc sulphate, and zinc sulphate only. Most other elements found in the solution are harmful to the electrolysis of zinc sulphate. I have never found any that I could confidently say were beneficial. This requirement seems relatively simple, but when it is understood that this process is to be applied to such a complex of ore minerals as is indicated above in the review of ore deposits, it will be understood that the production of zinc sulphate, pure, of the standard strength, is not the easiest problem in the world. And yet it is only this problem that has stood in the way, for all time past, of the manufacture of zinc electrolytically. All of the factors necessary to the production of a solid coherent plate of electrolytic zinc were known long ago, but it is only recently that we have been able to produce this pure zinc sulphate on a commercial basis and in large quantities, and have been able to obtain the electric current at such a cost as to make the production of electrolytic zinc a commercial possibility.

While it is doubtful that these gentlemen would agree concerning the most desirable methods for carrying out all the various parts of the process, it is noteworthy that they agree concerning the essentials involved. Perhaps their differences regarding details would not be so much of fact as of experience. The important point is that there are at least three plants in the United States at which electrolytic zinc is being produced commercially from ores of widely different origin and composition, by processes the developments of which have been practically contemporaneous and independent.

The Roasting Problem

Both Mr. Hall and Mr. French have given us rather more than a hint as to what the problem in roasting has been. The particular factor that interfered with the highest recovery when the roasted ferruginous ore was leached with sulphuric acid was the formation, in the roaster, of a complex compound of zinc and iron which is insoluble. It developed that the production of this material was largely due to roasting at too high a temperature. Mr. Hall mentioned that, "In roasting Colorado ores for the production of spelter, the writer has found as much as one-third of the total zinc in such ore to be insoluble in a relatively strong solution of sulphuric or hydrochloric acid." Mr. French stated:[3]

With proper adjustment of the roasting furnace conditions, it is not difficult to obtain extractions of 90 per cent. of zinc from ores containing 12 to 25 per cent. zinc, and in the latter case with as much as 25 per cent. of iron. As far as the author's experience goes, furnaces of the Wedge and Herreshoff type are admirably adapted to the roasting of this class of ore. A large Wedge furnace, with 7 hearths and a diameter of 22½ ft. (6.8 m.) is capable of roasting about 1¼ tons of this ore per hour, with unskilled labor, and gives a more satisfactory product than the smaller hand-rabbled furnaces. After roasting zinc concentrates containing 45 per cent. of zinc, there is little difficulty in extracting as much as 95 to 97 per cent. of the zinc.

There is every indication, therefore, that exceedingly high recoveries should be obtained from Montana ores which contain around 22 per cent. of iron and are readily concentrated to exceed 50 per cent. of zinc. The

[3] *Op. cit.*, 322.

general impression seems to be that the proper roasting temperature for subsequent leaching with sulphuric acid is around 600° C. I have understood for nearly a year now that this is the approximate temperature employed in the Wedge roaster at the Park City, Utah, smelter, working on oil flotation concentrates of around 40 per cent. zinc.

E. H. Hamilton, in a paper[4] on "Electrolytic Zinc Extraction at Trail, B. C.," stated the temperature of the Wedge roaster to be approximately 600° C. The ore had approximately the following composition:

	Per Cent.		Per Cent.
Lead	14	Magnesia	2
Iron	21 to 31	Sulphur	24 to 29
Insoluble	4	Zinc	19 to 24
Alumina	3	Cadmium	0.04
Lime	2		

The ore is crushed in tube-mills to the following size:

Mesh.	Per Cent.
On 48	3
On 48–100	10
On 100–150	3
On 150–200	12
Through 200	72
	100

and is then roasted in Wedge roasters having seven floors and diameter of 26 ft. (8 m.) with two arms to the floor and revolving once in 4 min. Forty tons are roasted per day from 25 per cent. down to 5 per cent. sulphur. The temperature of the hearths is approximately:

1st floor	....	....
2d floor	950° F.	(510° C.)
3d floor	1000° F.	(538° C.)
4th floor	1100° F.	(593° C.)
5th floor	1100° F.	(593° C.)
6th floor	1050° F.	(566° C.)
7th floor	....	....

Since the problem of roasting for subsequent leaching with sulphuric acid is the same everywhere, that is to eliminate sulphides and convert the zinc into an oxide or sulphate, it follows that the practice must be substantially the same everywhere, the time of the operation varying only with the fineness of the ore and the sulphur contents.

The Leaching and Purification Problem

On the other hand, this problem differs with each locality. On visiting the successful electrolytic zinc plants of the country, one finds no lack of understanding of the impurities that occur, of the reagents which must be employed, or of the reactions that take place. While

[4] *Trans.* Am. Electrochemical Soc. (1917), **32**, 217.

in some cases, past failures in leaching for electrolytic zinc were probably due to lack of consideration for things which were known, the difficulties encountered have been usually the more or less inevitable result of the large scale on which it has been attempted to operate. They have been attributable mainly to poor arrangement of the plant and to failure of some of the mechanical apparatus to operate continuously, particularly that connected with the filtration of the solution and the removal of the coagulated or precipitated impurities. It has been found absolutely essential to have a well designed plant, in which the apparatus is arranged in sequence according to the sequence of operations; in which lead pipe, and not iron or other substitute, is used where lead should be used; in which excessive pumping is avoided; in which reliable mechanical apparatus is employed and no one piece is so situated that it can become the solitary neck of the bottle, the temporary clogging of which might cause the solution to foul and so disrupt the operation of the entire plant as to require days for its resumption.

Power Requirements of the Zinc Cell

These requirements also are well understood, though they were not two or three years ago when most of the existing electrolytic zinc plants were planned. It was not appreciated that electrolytic zinc precipitation would become substantially a constant-voltage, constant-current process. Every operating superintendent has worked out series of power charts similar to Fig. 12 of Mr. Hansen's paper. The working part of this chart is that between 5 and 9 per cent. acid, and approximately 20 and 35 amperes per sq. ft. General practice has adopted 25 amperes per sq. ft., or slightly less, as the most economical current density. Working within these usual limits, a change of 15 per cent. in applied voltage with constant acidity will approximately double or halve the current density, whereas a change of 1 per cent. in the acidity of the solution, at constant voltage, will produce about a 15 per cent. change in the current density.

The problems of roasting, leaching, and purification having been largely solved, and a pure solution having arrived at the tank room, it is evident what ready means exist to determine what current density and rate of precipitation are most economical, power and other operating costs, interest on investment, and the price of zinc, all being taken into consideration.

As Mr. Hansen's Fig. 12 shows, there is no appreciable difference in the cathode production of the cell, per kilowatt-hour, at 25 amperes current density, between 6 and 8 per cent. acidity, and at 35 amperes the difference is not considerably greater. This change in acidity, however, which may be effected simply by altering the rate of flow of the incoming solution by means of the valves, will change the current density approximately 30 per cent. Of course, the actual acidity, which

may be employed over long periods of time, is determined by other factors related to the leaching and filtration; but it is evident that "acid control" can be a most effective means of current control for the brief periods when necessary changes are being effected in the tank room, or some external condition alters abnormally the voltage available at the tank room. According to general experience, there is no occasion, 95 per cent. of the time, for anything but constant voltage in the tank room; and, for the remaining time, a means of varying the voltage 5 per cent. either way is all that is necessary.

Design and Selection of Electrical Equipment

It is becoming apparent that all the conditions were not known or fully analyzed by the electrical equipment manufacturers who applied their machinery in the earlier electrolytic zinc plants. In these times of high costs, thorough analyses should be made to determine exactly the requirements which the tank room *must* demand of the electrical equipment, analyses unbiased by what has been done before. In this connection, the writer frankly acknowledges that in his paper[5] "The Substation Problem of the Electro-chemical Plant," that part of the discussion dealing with the voltage range of electrolytic zinc plants was unduly influenced, unconsciously, by the known characteristics of the electrical equipment already installed in such service. I feel that there is opportunity for greater resourcefulness than has been evidenced in the past. Since the electrolytic zinc process is substantially a constant-voltage, constant-current process, like the aluminum reduction process, and, like it, a process which should operate 365 days out of the year, I am confident that plans will be made to employ the type of electrical equipment which has the lowest first cost and the highest efficiency over the longest operating period. Continuous efficiency will not be sacrificed and initial cost unduly increased simply to take care of occasional abnormal conditions which resourcefulness can meet in other ways.

I expect to see the elimination of the motor-generator set from consideration for such service, on account of its low operating efficiency and high first cost. I expect to see a larger number of simple, shunt-wound, rotary converters employed, the most efficient machine obtainable, such as are largely used in the aluminum reduction industry; and, where a small voltage variation is needed, this will be obtained simply by reactance in the alternating-current supply circuit and variations of the shunt-field strength. This "reactance and shunt-field control" method of obtaining small voltage variations has not been used largely in America, except in the aluminum reduction industry, and in some of the older street railway systems; but it has been used extensively elsewhere, especially in Great Britain and her colonies.

[5] *Trans.* Am. Electrochemical Soc. (1917), **32**, 99.

For electrolytic service really requiring voltage variations greater than 5 per cent. plus and minus, I expect to see the installation of the most effective type of booster rotary converter, after all the various factors in the tank room have been given full consideration. The reasons for confidence in the suitability of the booster rotary converter for such service are set forth at length in my paper to which I have just referred.

Carbocoal

Discussion of the paper of C. T. Malcolmson, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 137, May, 1918, p. 971.

W. Rowland Cox,* New York, N. Y. (written discussion†).—The process described by Mr. Malcolmson undoubtedly represents a great stride toward conservation of our natural resources. Without discussing the subject from an economic standpoint, I wish further to emphasize the fundamental principles of the Smith process in order that its economic value may be fully appreciated.

The process is essentially a means of producing an ideal fuel, as regards its combustion qualities, by the removal of the so-called volatile matter from the coal, in the form of byproducts, which have value for other purposes far in excess of their fuel value. In other words, coals which contain large amounts of gas, tar, and ammonia, and are not suitable for domestic or industrial fuel, or for treatment in byproduct coke ovens or gas retorts, because they possess poor coking qualities, can be prepared for commercial use by the Smith process with a very high degree of efficiency.

Much work has been done along this line, both in this country and in Europe, in developing a means of preparing coal, as the economic advantages have long been recognized. To the best of my knowledge, the Smith process is the only one that has proved its commercial adaptability.

Distillation of coal at 900° to 1000° F. (480° to 540° C.) yields a large amount of tar and oils. The residue of the distillation, however, is a very friable semi-coke, wholly unsuitable for use as a fuel, unless it can be charged directly into a byproduct gas producer. The problem which confronted the inventor was then to convert this carbon residue into a commercial product, and it is in this step that the Smith process has overcome the obstacles which prevented a number of other methods from becoming commercially practicable.

It was found that by pulverizing the carbon residue it could be briquetted with pitch as a binder. Such briquets, however, were not smokeless, and possessed all the other disadvantages, such as softening

* Mining Engineer.

† Received Aug. 7, 1918.

during combustion, smell, and other characteristics of briquets made with a pitch binder.

The inventor found that by distilling the briquets made from the carbon residue, at a temperature between 1400° and 2000° F. (760° and 1095° C.), the material was completely devolatilized, and a briquet of high specific gravity was produced.

It was also proved that by making the first distillation incomplete, the final briquets burned very freely as compared with similar briquets made from anthracite or coke, and it is this rapid combustion that so distinctly differentiates this fuel from other low-volatile fuels now on the market.

As to the byproducts of the process, I would emphasize one feature. It is well known that low-temperature carbonization produces a high yield of light oils of the benzol series, but with such large amounts of paraffines present that the toluol will not be accepted by the manufacturers of explosives. The inventor and his associates, I am advised, have developed a means of removing the paraffines, and are producing higher yields of benzol and toluol than in ordinary coke-oven practice.

J. M. FITZGERALD,* Rochester, N. Y. (written discussion†).—Until the end of the war at least, Carbocoal will help to satisfy the enormous requirements of the Government for a smokeless fuel for the use of vessels engaged in crossing the Atlantic; just now, the Government is practically commandeering the output of the principal mines in West Virginia, Maryland, and Pennsylvania, producing the so-called "smokeless coals," for their use. The need for smokeless coal increases as more ships are launched, and it is entirely probable that within a year bunker requirements will have grown to such proportions as to demand practically the entire output of most of the mines that produce low-volatile coals in Pennsylvania, and for a large portion of the product of the Pocahontas and New River fields. About a year ago, ships were required to carry a "sufficient quantity of smokeless coal to carry them for two days through the submarine zone;" as the submarines now have no limits to their zone, it has become necessary to use smokeless coal for the entire trip between America and Europe.

This new fuel has been given a most thorough test by the United States Navy, and it has been shown to be not only smokeless, but particularly suitable for marine and locomotive service where a high-grade fuel is demanded because of restricted grate and boiler capacity.

As to the yield of oils by this process, Dr. Mollwo Perkins, in a recent paper[1] on the importance of the oil requirements of the Navy, spoke of recovering oil from coal by a low-distillation process similar, as to tem-

* President, Davis Machine Tool Co.

† Received Aug. 13, 1918.

[1] *Jour.* Institution of Petroleum Technologists (Apr., 1918), 4, 121–125.

perature, to the primary operation of the Smith process. Mr. Perkins stated that to produce 300,000 gal. of oil daily, only 15,000 tons of raw coal would need to be treated, and that the erection of suitable plants in the coal districts would be simple. The adoption of such measures would release, for other use, 100 tank steamers now employed in carrying oil to England from Mexico and other remote places.

Dr. Perkins' figures are sensational when one stops to figure that to build 100 tank steamers, averaging 6000 tons dead weight, would involve an expenditure of around $120,000,000. To build plants that will treat 15,000 tons of coal per day, according to estimates, would cost only $25,000,000. While America will not be able to effect so large a saving in ocean transportation, the building of these plants in the important coal fields will introduce economies in railroad transportation, and reduce the cost of power and fuel for domestic use.

An important subject in every home is the supply of domestic coal. In the east, anthracite coal is used almost exclusively for domestic purposes; little coke is used, because, owing to its bulk and the corresponding increase in freight charges as compared with coal, it can not readily move to points far from its place of manufacture.

Only a few months ago, Professor Breckenbridge, of New Haven, estimated that the anthracite coal measures would be exhausted in about 100 years. One of the dominating features of the new process is that it eliminates from further consideration the possible exhaustion of anthracite; Carbocoal is smokeless, is said to be even more cleanly for domestic use, and it suffers no breakage. As bituminous coals in nearly all of the fields of the United States are susceptible to this treatment, this smokeless fuel can be made available for use in many sections so distant from the anthracite fields that the cost of hard coal is prohibitive. This, it is argued, will go far toward the saving of transportation and of cars.

Briefly, the Smith process gives promise of supplying to nearly every bituminous producing section of the country the means of manufacturing its raw coal without loss of the valuable byproducts. What has retarded the more general installation of byproduct coke plants in this country has been the fact that, to dispose of some of the most abundant byproducts, the plants would have to be located near large centers of industry and population. The Smith process makes it practicable to treat, by the low-distillation method, coals of proper quality wherever they may be mined. The valuable byproducts can be shipped to any point. If there is not sufficient local demand to consume the full output of Carbocoal made from the residue, this fuel can be shipped in competition with run-of-mine or prepared coal. Having the same weight as anthracite or bituminous coal, it will move at the same freight rate, and not bear the handicap of extra charges that are maintained on coke by reason of its bulk.

NEWELL W. ROBERTS*, New York, N. Y. (written discussion†).—One of the most valuable points brought out in Mr. Malcolmson's paper is the quantity and quality of the byproducts.

In the early days of coal distillation, the carbonization of coal was carried on primarily for the yield of gas, and the tar resulting therefrom was considered a necessary evil. The yield of tar, however, although considered large in those days, was relatively small as compared with present-day results. Even yet we find that the yield of byproducts does not fully meet our requirements. The coke-oven plants are producing an average of little more than 7 gal. (26.5 l.) of tar per ton of coal carbonized, although some are producing as high as 9 gal. (34 l.) per ton. In addition to the tar, by stripping the gas, some 2 to 3 gal. of light oil is obtained, the average yield being slightly under 2.5 gal. (9.4 l.), of which approximately 0.3 gal. (1.13 l.) is toluol.

The Smith process produces an average of 30 gal. (113.5 l.) of tar from both distillations, from coal having volatile contents of 35 per cent.; approximately 24 gal. (91 l.) are obtained from the first, and 6 gal. (22.7 l.) from the second distillation. This tar is unusually light in gravity, ranging from 1 to 1.06, while in some cases the gravity has fallen below 1. The difference between Smith tar and coke-oven tar is very well brought out in Mr. Malcolmson's paper. Coke-oven tar contains 62 per cent. of pitch, and the tar from the Smith process less than 40 per cent. This, however, is to be expected. In the first place, the primary distillation is carried out at a low temperature, and there is no cracking of the oils and vapors. That the difference in yields is due to the difference in temperature at which the two processes are operated is very well illustrated by a simple cracking tube. Take almost any oil and pass it through a tube at 800 to 900° F. (430° to 480° C.) under atmospheric pressure, and there is practically no cracking. Increase the temperature to 1500° F. (815° C.) and large quantities of gas and tar are formed, the latter containing 40 to 60 per cent. of pitch. This is what occurs in coke ovens; the oils come in contact with the hot coke, or the heated walls of the retort, and are cracked, producing gas and reducing the yield of tar.

The value of the tar from the Smith process can only be estimated, but it will undoubtedly be more valuable than any coal tar now on the market. Of the 30 gal. of tar produced by both distillations, 15 to 20 gal. (57 to 76 l.), dependent on the raw coal used, can be recovered in the form of marketable oils.

The light oil from the tar, as well as the light oil from the gas, contains, as might be expected, a certain quantity of paraffin hydrocarbons. These vary from 4 to 20 per cent., depending upon the nature of the coal used. Ordinarily, light oil containing paraffin hydrocarbons in the amount just mentioned would be valueless for use in the manufacture of c. p. benzol and

* Vice-president, International Coal Products Corporation.

† Received Aug. 7, 1918.

toluol, but with the Smith process it has been found possible entirely to eliminate the objectionable paraffin hydrocarbons. After the demand for c. p. toluol has ceased, these light oils, as has already been demonstrated by actual tests, can be used as an excellent motor fuel. The middle and heavy oils, while at present not attracting so much attention as the lighter fractions, should be in great demand in the future.

At present there is a good market for creosote and flotation oils, and all the oils produced at the Irvington plant have been sold at a very good price for these purposes. No attempt has as yet been made to separate the tar acids from the oils, and the crude cuts, just as they are taken from the still, are used as such. The higher fractions are rich in tar acids, containing as high as 40 per cent., and averaging well above 30 per cent. acidity.

The middle fraction, distilling between 170 to 230° C., is rich in cresylic acid, and laboratory tests have shown that as high as 0.5 gal. of acid can be obtained from each ton of coal carbonized. A small quantity of phenol is also present in the middle oil fractions but it is doubtful whether it would pay to extract it. The light oil fraction from the tar, distilling below 170° C., also contains tar acids, but in much smaller proportions. The analysis of this fraction shows it to contain about 10 per cent. of tar acid, the bulk of which is cresylic. With a domestic production of cresylic acid, the American markets will be well supplied, and its importation in large quantities will no longer be necessary. This should result in a lower cost, and as most forms of commercial cresylic acid darken on storage, which in numerous cases is found objectionable, it should be possible to put on the market a product more satisfactory to the consumer.

As to the oil obtained by stripping the gas, this is obtained in the same quantity as from coke ovens. It is richer in toluol, yielding approximately 0.35 gal. (1.32 l.) per short ton (907 kg.) of coal carbonized. In addition to the tuluol recovered from the gas, 0.13 gal. (0.49 l.) is also obtained from the tar, making a total of nearly half a gallon from each ton of coal, or practically double the average yield from coke ovens.

The Smith process also produces a good yield of ammonia. The first or low-temperature distillation yields 4 or 5 lb. (2 kg.), and the second or high-temperature distillation 15 to 16 lb. (7 kg.) of sulphate, a total which compares very favorably with coke-oven and gas-house practice.

Charles M. Barnett,* New York, N. Y. (written discussion†).—During the last few years, much thought has been given by coke-oven engineers to the distillation of coal at low temperatures, to obtain a smokeless fuel and a larger yield of tar, benzol, etc., than is obtainable in existing by-product coking processes. The intermittent process, as used in England,

* Of the Clinchfield Coal Corporation. Formerly Pres. and Gen'l Mgr., Chesapeake & Ohio Coal and Coke Co.

† Received Aug. 19, 1918.

has many disadvantages: Restriction to the use of certain coals; charging and discharging of retorts is costly; fuel obtained is bulky, low in specific gravity, and difficult to handle without excessive breakage in transportation; in carbonization, coals nearest the sides of the retort are coked more than those in the center, making a uniform yield impossible; yield of ammonia is low.

The Smith continuous retort appears to have overcome these difficulties. The higher the volatile content, the higher the yield of oils. No special coal is required for the process. Coal which has a tendency to swell in carbonization can be easily handled in this retort, which would be impossible in the intermittent process. The interlapping paddles agitate and mix the material thoroughly, and each particle of coal is brought into intimate contact with the sides of the hot retort, giving a uniform product.

The question of feeding coal into the retort and discharging the carbon residue therefrom, which has been found troublesome in all other continuous processes, has been solved satisfactorily in the Smith process. The heating system of the retort enables the operator to obtain any desired temperature at any part of the retort; access to the gas burners is obtained underneath, and control of the air for combustion is easily accessible, being adjacent to the gas burners, so that adjustments to the gas and air can be made at the same time. The dampers connecting the heating flues to the waste-heat flue are operated from the top of the retort. Air used for combustion is pre-heated in the recuperator underneath the retort, cold air and waste gases flowing countercurrent to each other.

The carbon residue obtained from the primary carbonization is a fuel of uniform quality, and averages 8 to 10 per cent. volatile matter. It is easily crushed and would make ideal powdered fuel, with a considerable saving of national resources through recovery of the valuable byproducts, as compared with present methods of using raw powdered bituminous coal. The carbon residue could also be stored with less danger of spontaneous combustion than raw bituminous coal. This opens up a large field for its economical storage in the tropics and at bunkering stations around the world.

As to the briquetting of the carbon residue, the pitch employed (only a small percentage) is obtained from the tar distilled in the plant, and it is found that more than enough for the requirements of the briquetting plant is available. This is an ideal way of disposing of the pitch, as in normal times pitch does not find a ready market in large volume. In the secondary carbonization, some of the pitch is recovered, some gasifies, and the remainder combines as carbon with the finished product.

The process is also valuable for carbonizing coals of high sulphur content, such as certain Illinois coals, which are not suitable for metallurgical coke, but make a good domestic fuel in the form of Carbocoal.

CHARLES CATLETT,* Staunton, Va. (written discussion†).—I witnessed a test of Carbocoal on a Mallet locomotive on the Clinchfield road in September, 1917. The locomotive was pulling approximately 3000 tons up a ½ per cent. grade at a speed of between 9½ and 11 miles an hour. A comparison was presented between Carbocoal made from the Upper Banner coal, mined by the Clinchfield Coal Corporation, and a former test made under very similar conditions when using straight Upper Banner coal. There was no difficulty in keeping the steam gage steady between 195 and 200 lb., and the results indicated by the two tests were approximately the same. But taking into consideration all the conditions surrounding the tests of the Carbocoal, the impression made upon me was that the latter would have afforded even better results if the conditions of the tests had been fixed with reference to that particular fuel.

The engines of the Clinchfield road, after many experiments, had been drafted and arranged with special reference to Upper Banner coal, and the fireman was familiar with what was necessary to get the best result from it. This coal, which is considered one of the best locomotive fuels in the East, carries about 32 per cent. of volatile matter, and is strongly coking; yet in this test it was replaced by Carbocoal, carrying not over 4 per cent. of volatile matter, and having no coking qualities, without any change in the drafting or arrangement of the fire-box. It was evident that the fire-box could have contained and consumed a very much larger amount of Carbocoal than was fed to it. A small matter bearing upon the test was the fact that the briquets were of domestic size, and being of round shape would not pile up on the shovel as would run-of-mine coal; thus, with the same exertion the fireman could not put the same weight of fuel into the fire-box when firing Carbocoal as when firing run-of-mine coal. This could easily be obviated by a change in the form of the scoop, or in the shape of the briquet.

One great advantage of the Carbocoal, as compared with other forms of fuel, is that brought about by the formation of the semi-carbocoal at a low temperature. When coal has been coked at a low temperature and allowed to cool, it no longer softens and continues the process of coking when again heated. The character of coke so formed is entirely different from that of coke made at a high temperature. It probably occludes more oxygen, and is more readily acted on by the oxygen of the air, and probably burns with less excess of air than is required for burning other fuel.

One interesting factor is the marked reduction in the formation of clinkers, as compared with the coal from which the Carbocoal is made;

---

* Chemist and geologist.

† Received Aug. 19, 1918.

this is hard to understand. The Carbocoal will naturally carry somewhat more ash than the coal from which it is made, but owing to the uniform grinding and mixing of the coal, the ash is distributed uniformly through the material, and probably every particle of the ash is covered with a layer of soft coke in the initial coking. This may have some effect in reducing the tendency of the ash to clinker, and may enable it to drift away from the zone of highest temperature before it becomes so fused as to give trouble.

In addition to its value, as described, for ordinary gas producers or Mond gas producers, I imagine the Carbocoal would have special value in connection with suction gas plants. My impression has been that the wider adoption of such plants has been retarded by the difficulty of securing adequate supplies of suitable fuel.

While Carbocoal undoubtedly can be used for steam purposes, and its use under certain conditions is desirable, it looks to me as if it would have much greater value in the domestic trade, where it could take the place of anthracite in those sections which are at present remote from anthracite supply.

I believe one of the difficulties in connection with the production of large amounts of ammonia from coke-oven gases has been the apparent limit to the demand, in many sections, for coke; but the demand for such a material as Carbocoal will be far more extensive and universal, and it is not unreasonable to expect that in time a large amount of nitrogen compounds, so greatly needed in agriculture, will be derived from this source.

F. R. Wadleigh,* Washington, D. C. (written discussion†).—The Carbocoal process, as patented and developed by Mr. Smith, would seem to have greater possibilities than any other fuel development of late years, or indeed for many years. Low-temperature distillation of coal is not new, of course, but the experimental results obtained by the Smith process go far beyond and differ from all previous work of the kind, both in methods of operation and in the products obtained. The process is a long step toward the conservation of fuel resources; indeed, its development in foreign countries, especially in England, France, Italy and Spain, or wherever suitable coals are available, will aid in solving many important fuel problems, as well as others not strictly pertaining to fuel, as such.

In Great Britain, for instance, where all oils must either be imported or made from coal or shales, but where the best grades of high-volatile coal are available, a Carbocoal plant would be highly profitable; the Carbocoal itself would fill the demand for a smokeless house and steam fuel, while the yield of byproducts, especially the oils, would help to reduce

---

* Mining Engineer, Emergency Fleet Corporation.

† Received Aug. 17, 1918.

the quantity of oil to be imported, while assuring a definite and steady supply and no uncertainty as to losses of ships. A plant carbonizing 2000 tons of coal per day would produce about 15,000,000 gal. per year of various oils; to import the same amount from the Mexican oil fields would take about five tanks, each making five trips per year.

Regarding Carbocoal, the fuel, it is understood that the railroads have allowed the same freight rates for its transportation as for coal. In this respect, it will have a considerable advantage over coke, which is always charged a higher rate than coal, owing to its bulk. As regards transportation, experiments have shown that Carbocoal has decided advantages in loading and unloading cars, as well as in freedom from breakage, the latter being practically nil.

The fact that the process is entirely self-contained is a distinct asset—everything it needs, it makes; only one raw material—the coal—has to be supplied.

As a means of conserving our supplies of anthracite coal, Carbocoal presents a most promising future; not only has it been proved to be a better domestic fuel than anthracite, but the fact that Carbocoal can be made from any high-volatile coal solves the serious question of distributing anthracite. The fact that Carbocoal, as now manufactured commercially, contains less volatile than anthracite insures its smokeless combustion; its uniform shape and size also make for improved combustion.

The writer has seen Carbocoal burned on a locomotive, running with 60 per cent. cut-off, at a rate of 166 lb. per sq. ft. of grate per hour, and with 16-in. draft in the smokebox, with absolutely not a vestige of smoke; burning with a long yellowish-white flame, yet every part of the surface of the fire entirely visible, even to the unaccustomed observer—a performance impossible with either coke or anthracite.

On the same locomotive (a standard "Mikado" as used in freight service) at a rate of 80 r.p.m. and 50 per cent. cut-off, over 11 lb. of water were evaporated per pound of dry fuel, from and at 212° F.; yet the Carbocoal contained only 12,291 b.t.u., showing a boiler and grate efficiency of 84 per cent. It would seem from such performances that Carbocoal is the answer to the smoke question on locomotives—a truly large field, when it is remembered that one railroad alone buys some 3,000,000 tons of anthracite, coke, and so-called "smokeless" coals, solely to reduce the smoke nuisance.

Other possibilities in the use of Carbocoal would seem to lie in its substitution for coke in various industrial processes, such as beet-sugar manufacture, smelting, and various chemical processes, where a smokeless fuel is required, and possibly also for foundry use. This would be especially the case west of the Mississippi River, where low-volatile coals and good coking coals are comparatively scarce. The high-volatile,

high-nitrogen coals in Washington should be especially well adapted for the Carbocoal process, and there would be a ready market, both for the Carbocoal and for the byproducts.

One rather unusual feature of the process, as applied to fuel, is the fact that it greatly reduces the percentage of oxygen in the Carbocoal as compared with that in the original coal. In the case of one well known Eastern coal, which normally contains from 7 to 10 per cent. oxygen, the Carbocoal produced from it contained slightly less than 1 per cent. As a given amount of oxygen has about the same effect on coal combustion as a similar percentage of ash would have, or, in other words, the B.t.u. in dry coal vary directly with the percentage of oxygen, this may explain some of the extraordinary results that have been obtained with Carbocoal in boiler and locomotive furnaces.

Another promising feature is the entire suitability of the semi-coke, or coke residue, obtained after the first distillation, and before briquetting, for use in byproduct gas producers; here its entire freedom from caking, or tar, its uniform quality and ease of conveying, in addition to the fact that the first distillation does not remove any of the original nitrogen in the raw coal, all make the semi-coke an ideal fuel for such use.

This semi-coke would also seem to offer possibilities for use under boilers, either stoker or hand-fired, where smokeless combustion could be easily obtained. Its use under such conditions would, however, be dependent upon location, as the semi-coke could not well be transported for any distance.

As a smokeless fuel for the Navy and Merchant Marine, especially in war time, Carbocoal should be satisfactory. Indeed, it is understood that tests made by the U. S. Navy at its Annapolis testing plant have given quite remarkable results, both in evaporation, quick response to draft changes, and entire absence of smoke. As a result of these tests, the Emergency Fleet Corporation has taken up the question of using Carbocoal on ships passing through the submarine zones.

Air Blasts in the Kolar Gold Field, India

Discussion of the paper of E. S. MOORE, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, p. 687.

W. F. SMEETH,* Bangalore, Mysore, India (written discussion†).—Before dealing with the air blasts, I would like to clear up a geological point. The author states that the matrix of the conglomerate resembles a hornblende schist. This is a misapprehension. The conglomerate

* Chief Inspector of Mines, Mysore, India.

† Received Aug. 16, 1918.

band, or series, is composed essentially of granitic gneiss with sporadic patches containing pebbles—or lumps—of granitic material and fragments, or included patches, of the overlying hornblende schists and banded iron-ore formation. The conglomeratic gneiss is oblique to the banding of the schists and penetrates them in tongues. Toward the south of the field it cuts across the schist bands for about 2 miles, and similar granitic material is found in the mines, at a depth of 3000 ft. or more, in bands or tongues which give evidence of intrusive action in relation to the hornblende schists. It is not understood in what sense the author regards this material as similar to the basal Huronian conglomerates of America, but I gather that he considers it to be sedimentary in origin and that he differs from my view that it is an intrusive gneiss with autoclastic pebbles and included fragments of the schists. Also, it is not clear in what way this conglomerate, which is admitted to be younger than the schists, can be regarded as basal or how it can indicate the presence of a syncline in those schists. Perhaps the author would kindly further elucidate his views.

The author criticizes the use of the term "air blast" and in this everyone will, I think, agree with him. Many years ago the term was in use in the Cornish mines where rock was encountered which showed a tendency to fly, or split off violently in small fragments; this was referred to by the miners as "airing." Some 15 or 20 years ago similar phenomena became prevalent in the Kolar Field and were referred to in the same terms, but about the same time more than usually violent effects, which involved the displacement of considerable masses of rock, the smashing of large timbers and production of violent shocks, which were distinctly and alarmingly felt at surface, began to attract attention.

A study[1] of a number of cases led me to divide these phenomena into two classes, one of which I called "quakes" and for the other I retained the term "air blast," then in common use.

The distinction which I endeavored to make was that quakes were larger and more serious phenomena, involving considerable destructive effects underground, accompanied by perceptible shocks at surface, and due, essentially, to the sudden fracture of pillars or blocks of quartz left standing in the workings during the course of mining operations. The failure of such pillars was considered to be the result of compressive or shearing stresses due to superincumbent weight, which was a function partly of the depth from surface and partly of the extent to which the surrounding quartz had been stoped out, thereby increasing the weight to be supported by the pillar. The suddenness and violence of shock depends on the physical characters of the quartz and of the overlying and underlying rock (hard crystalline hornblende schist and epidiorite)

[1] Air Blasts and Quakes in the Kolar Field. By W. F. Smeeth, M. A., D. Sc. Mysore Geol. Dept. (1904), *Bull.* No. 2.

which do not permit of quiet deformation, or adjustment, with the result that disruption is correspondingly violent when the breaking stress is reached.

Air blasts, on the other hand, were restricted to bursts of rock, whether of quartz, hornblende schist or trap dyke, which occurred in circumstances which seemed to preclude superincumbent pressure as an essential factor, and were considered to be due to intrinsic strain in the particular mass of rock involved. I may add that the term "air blast" has been practically discarded for some years, and these occurrences are now commonly referred to as "rock bursts."

At the time the Bulletin quoted above was written, these rock-bursts were much less serious phenomena than the quakes. Small, and sometimes moderately large, pieces of rock were thrown from the working faces with disruptive violence accompanied by considerable detonation, but the effects were very local, timbers were not affected and it was not considered that any perceptible shocks were felt at surface. Since that time these rock bursts have been recognized as being of greater magnitude and accompanied by damage to timbers and perceptible shocks, so that the visible and sensible distinction between quakes and rock bursts has almost ceased to exist, although I am of opinion that the genetic distinction is still valid. Such distinction can be recognized, however, only when the scene of a particular occurrence is known and can be carefully inspected; and in many cases this is not practicable.

In his paper, Prof. Moore agrees that the rock bursts are due to a condition of strain in the portions of rock in which they occur, and considers that the strain is the result of regional compression which operated in former times, and that the rocks are still, on the whole, under great compressive stress. In the next paragraph (p. 693) he states: "in some places the rocks have yielded to compressional forces, which have produced the movements indicated by the slickensides, while in others they have not been compressed sufficiently to cause them either to shear or to rupture, and in these spots the potential energy gives rise to the blasts."

The latter statement appears to contradict the former, but I presume that what the author means is that in some places the strain has been relieved by fracture and movement while in others the rock is still under great compressional stress. This is quite a reasonable view and I shall refer to it later. With regard to the larger shocks, or quakes, due to the failure of pillars of quartz in stoped areas, the author admits that they seem to owe their origin partly to the superincumbent load but adds that "their violence can only be ascribed, like that of the air blasts, to some latent energy or strain in the rocks of this area." With this view I do not agree. If we have a pillar of quartz under great stress due to superincumbent weight, and if, in addition, some of the adjacent rock

is in a condition of intrinsic strain due to other causes, we may obviously get any combination of a quake and a rock burst; the one may set the other off and the resulting effects may be greater than would have been the case with either acting alone. But, in my opinion, the quake, or shock due to failure of a pillar under weight, may, and often does, take place without any of the rock concerned being in a condition of what we may call intrinsic strain, and therefore, without the production of what I have defined as an air blast or rock burst. In so complex and difficult a problem it would be a pity to confuse or obscure any legitimate and reasonable distinction which can be detected among the very varied phenomena which are known to occur, and it appears to me that Prof. Moore's contention, that the violence of the quakes is really due to some condition of strain resulting from original compression, tends to such confusion and merely obscures the issues. In my opinion, as already stated, the quakes are due simply to superincumbent weight and their violence is a function of the natural physical constants of the rock involved.

As an illustration of this we may take the case of the Rand mines of the Transvaal where, in recent years and with increasing depth, shocks due to failure of pillars have become troublesome and have been reported upon by a special Commission. In those mines, rock bursts in shafts, drives or crosscuts, far removed from stoped areas, are practically unknown, and the strained rocks, with which we have to deal at Kolar, do not appear to exist. This is useful evidence that violent quakes may occur as the result of pressure due to weight alone, quite independently of strain due to other causes, and the evidence is clearer than that obtainable at Kolar where both sets of conditions are frequently associated. Such association is, however, no justification for allowing our ideas to become confused.

My object in again drawing attention to the genetic difference between rock bursts and quakes is not for the purpose of offering criticism, or for the sake of establishing a mere academic distinction, but rather with a view to a practical working policy in dealing with these dangerous phenomena. When I started my investigation, some 17 or 18 years ago, rock bursts were not very serious features and little was done to guard against them. Quakes were comparatively rare and were regarded as bigger air blasts or as falls of ground. Comparatively little timber was put in, except in shafts and to support heavy ground, and systematic filling of stopes was practically unknown. The shafts were nearly all inclined and carried down along the course of the quartz veins or shoots, and pillars of quartz or poor rock were numerous throughout the stopes. The recognition that pillars were a source of danger, which was bound to increase with the extension of stoping and with increase of depth, led to a general change of policy. Inclined shafts have, in recent years,

been carried in the solid hanging or footwall rock. In the case of several of the old shafts, which had been smashed up, time after time, owing to the failure of some of the supporting pillars, the bold step was taken of entirely removing these pillars and replacing them by timber and packs of waste rock, with the result that most of the trouble has ceased.

Stoping is planned, as far as possible, to avoid the leaving of small pillars by taking out the ore in large blocks as rapidly as possible and leaving large blocks of untouched ground between them. In the leaving of these large blocks advantage is taken of poor zones between the payable shoots, but where these are not available large blocks of payable ore may be left for future exploitation.

Systematic filling with waste rock, some of which is sent down from surface, has been extensively developed and, in the steeper mines, methods have been devised for securing considerable consolidation of the packing. At first, it was customary to carry a stope down for a depth of 30 ft. (9 m.) and then put in a stull and fill the excavation with waste rock. Another 30 ft. was then stoped below the first stull and a second stull, with packing on top, was put in. The final 30 ft. was then taken out and similarly packed. The result of this method was that the three separate sets of packing were poorly consolidated and afforded little support for the hanging until the latter had closed down considerably and caused dangerous strain in adjacent pillars or in the more massive bands of rock in the hanging itself. These strains were relieved by sudden fractures accompanied by severe shocks, the smashing of heavy timbers and the filling up of levels and stopes with broken timber and rock. In other words, although this filling was doubtless of some service, and was preferable to the practical absence of filling previously in vogue, it failed to prevent a marked increase in the number and intensity of the quakes with increase of depth and extension of stoped areas.

In this connection it may be as well to note that failure of pillars under excessive weight is not the only source of quakes, and it is remarkable that quakes have been much less frequent in the Mysore mine, where the stopes dip at 45° to 50°, than in the Champion Reef and Ooregum mines where the dip is from 60° to 80°. In the latter mines the stress on pillars, due to weight, will be very oblique to the axis of the pillars, and failure will be due, largely, to shearing forces. Where the dip is very steep, much of the weight will go to produce a longitudinal thrust, in the direction of the dip, on the beds or bands of rock in the hanging, and as these vary in texture and schistosity we may expect that some of the more massive bands will take upon themselves the greater part of the burden; and if allowed to bend, to any great extent, they are liable to snap suddenly with the result that a disastrous quake is produced. The importance of supporting the hanging as early as possible is obvious, and the following method has been adopted, for some years, with a view to get-

ting in the filling before any wide extent of hanging is exposed, and of obtaining as much consolidation as possible.

A heavy packed stull is put in at the back of the lower level. From the level above, a stope, 30 ft. (9 m.) in length, is carried down to the bottom stull as rapidly as possible, and stulls, covered with 4 by 4-in lagging, are put in at depths of 30 and 60 ft. to protect the workers from loose fragments or rock bursts during this operation. The ends are also boxed in. When the stope is finished, the laggings are removed, and sometimes also the intermediate stull pieces, and waste rock is shot down the whole depth of the stope from the level above. The next stope is similarly treated, and so on until the entire block has been removed. The method has proved satisfactory in operation and there is little doubt that it has saved many quakes though it has by no means entirely obviated them. It is impossible to get any filling which will take up its work at once without material shrinkage, whether the filling be waste rock or the water-borne sand which is now so largely used in the Transvaal. The hanging will therefore settle down to an appreciable extent, and in the case of hard rocks with low elastic limits the pressure will be unequally and dangerously distributed on certain pillars, or the more solid bands in the hanging will reach their limits of tensile or shearing stress and yield with sudden violence.

Other methods of stoping and filling are at present under trial, which I will not refer to here.

I may now turn for a moment to rock bursts and endeavor to point out how they differ from quakes, and to supplement the illustrations given by Prof. Moore. There is no doubt that they occur in stopes, but in such places the evidence as to their nature and origin is complicated and obscured by the occurrence of quakes, falls of ground, and other effects of movement and superincumbent weight. For more distinctive evidence we must go to drifts, crosscuts, and shafts, which are being excavated in solid rock far removed from stopes, in which the superincumbent weight is merely that due to depth. As the rock bursts have been known to occur at all depths from about 600 ft. (183 m.) below surface downward, it is obvious that the mere weight of the overlying rock can contribute little, if anything, to the causes that produce these violent disruptions.

They occur most frequently in the quartz of the veins—probably due to the fact that a greater footage is driven in quartz than in other rock—but, contrary to what Prof. Moore states, they are not of any considerable magnitude or violence in this material. Occasionally they have been known to occur in the trap (dolerite) dykes which cut across the formation from east to west or north to south, and they occur fairly frequently in the more massive hornblende schists and epidiorites which form the mass of the country.

Sometimes they occur at or close to the working end while excavation is in progress; more frequently, some little time after the excavation has been made, as though the internal strain took some time to reach a critical point, and occasionally the effect is delayed until several years after the excavation (such as a shaft) has been completed and used.

The bursts are quite sporadic. A working may be driven for many feet, and even for thousands of feet, with no sign of trouble when, without warning, a burst or a series of bursts may occur, or a zone or patch of rock may start firing itself off for some considerable time, and the working may have to be suspended until the display is finished. A few specific cases may be quoted in illustration.

In driving the 1940 level, Champion Reef, annoyance was caused by small pieces of quartz bursting from the roof. In one section, where the quartz was 10 ft. (3 m.) wide, the trouble became so bad that work had to be stopped and the quartz fired itself out in a wedge extending upward for 8 or 9 ft. above the roof of the level, and then stopped. Except for the levels at every 100 ft. (30.4 m.) there was no excavation below this section nor for 1300 ft. (396 m.) above it. Superincumbent weight appears therefore to be excluded as a cause of these bursts and, moreover, no such bursts were experienced in driving the 1840 level above nor the 2040 level below. The circumstances appear to exclude existing regional compression, also, as a cause and suggest that the bursts were due to local internal strain in the section of quartz affected.

Instances of bursts in the trap dykes are not numerous. A couple of years ago I was passing along a level in the Mysore mine which was driven through a zone of poor, unstoped, ground. The level passed through a transverse dyke of a few yards in width, the surface of which was much cracked, owing, doubtless, to long exposure. It looked safe enough and I dug out a piece as a specimen. I had not proceeded more than 10 yards or so along the level when there was a loud bang and about 100 lb. of the dyke was thrown out across the level. I was told that similar bursts had occurred in this dyke on previous occasions.

A severe burst occurred in Gifford's shaft, Champion Reef, at a depth of less than 1000 ft. (305 m.) from surface. It is a vertical, circular shaft, lined with brick, and was being sunk in solid rock some thousands of feet from any mine workings. Its depth, at the time, was 1090 ft. (332 m.), the brick lining was down to 34 ft. (10.3 m.) from the bottom, and no bursts or other trouble had been experienced. On the day in question, the exposed surface below the bricking was carefully cleaned down and all loose removed. The stage was lowered and drilling started. About 20 min. afterward there was a loud report, accompanied by shock, and some 80 tons of rock burst from the west side and fell into the sink. In this case the depth from surface was small and the noise and shock, which are stated to have been heard and felt, are against the explanation

that the occurrence was merely the breaking way of a large mass of loose material.

We may next take a case in which there could be no suggestion that the burst was due to a fall of loose. Carmichael's shaft, Champion Reef, was being sunk, on the underlie, at a depth of 4700 ft. from surface (nearly 4000 ft.—1219 m.—vertical). The hanging-wall of the shaft was timbered and lagged to within 10 or 12 ft. of the sink. On the footwall the skip road had been completed to within 25 ft. of the bottom and below that bearers had been put in. A severe burst then occurred, accompanied by a shock which was felt and registered at surface. The footwall was broken up for 50 ft. (15 m.) above the bottom, many tons of rock were thrown up and fell to the bottom of the shaft and the skip road and timbers were much damaged. Neither the hanging, nor its timbers, nor the sides of the shaft showed the least evidence of disturbance or injury. The shaft was well within the solid hanging, some 70 ft. west of the lode, and there was no stoping or excavation (except the shaft itself and its crosscuts) within 1000 ft. (305 m.) of the point where the burst occurred. Moreover, no trouble of this kind had been experienced, previously, during the sinking of the shaft. All the circumstances point to intense local strain in some particular mass of rock at the point where the burst occurred.

One more case may be given, in which the burst occurred several years after the shaft had been completed. Garland's shaft, Champion Reef, is an underlie shaft the upper portion of which followed the lode and was therefore surrounded by pillars and stopes and had suffered, from time to time, from quakes. In the lower levels it passed into the solid hanging and at the point where the burst occurred it was 70 ft. (21 m.) west of the lode in solid rock. Little trouble had been experienced in the portion carried with the hanging wall. About noon of the day in question I had occasion to pass up the shaft, from the 35th to the 30th level, in company with Mr. Henry Gifford, the superintendent of the mine, and we were discussing the satisfactory results of keeping these shafts well within solid rock and away from the stopes. The shaft was fully timbered with square sets and complete lagging and the timbers showed no sign of pressure or movement. A few hours later a severe burst occurred between the 32d and 34th levels; I myself felt the shock at a distance of nearly 2 miles from the shaft and the shock was duly recorded on the seismographs at Ooregum. I went down next morning and found that the footwall of the shaft had burst for some 30 or 40 ft. above the 33d level; the 9-in. timbers were smashed and thrown into the shaft along with tons of broken rock. Further, a considerable portion of the hanging below the 33d level was also blown out and the timbers and lagging smashed. Probing with a stick showed that the roof of the shaft had been blown out to a height of some 8 ft. (2.4 m.) above the

original timbers. There was a crosscut from the shaft and a level and some stopes 70 ft. (21 m.) east of it, and in these, beyond the shaking down of some pieces of loose, there were no signs of movement or fracture. In this case, also, the bursts appear to have been due to the release of intense local strain within the solid rock without any evidence of pressure or movement in the immediate environment.

The foregoing cases will serve to show the character of these rock bursts, which appear to be more frequent and violent in the Kolar mines than anywhere else. It does not seem possible to suggest any means of preventing their occurrence, but a great deal has been done to protect workmen against the more numerous bursts which are not of exceptional violence. In vertical shafts a movable protective shield is provided below the point to which the brick lining has been put in. In underlie shafts and in many winzes, drives and crosscuts, either permanent or temporary timbering is carried as close to the working faces as possible. When a patch of ground which shows a tendency to burst is being driven through, work is frequently suspended to give the strains a chance to relieve themselves. Some bursts are so unexpected or so violent that no amount of care or protection is of any use and regrettably large loss of life, or injury, occasionally occurs. Efficiency of protection must, however, be judged by average results and, considering the large number of quakes and rock bursts which occur, the average results must be regarded as indicating a considerable measure of success which will, I hope, still be increased. For some years past a well-equipped seismological observatory has been installed on the field by the mining companies under the management of Messrs. John Taylor & Sons. This is in charge of H. M. A. Cooke, Superintendent of the Ooregum Company, who has devoted much time and ability to securing records and subjecting them to critical scrutiny. The number of shocks recorded depends on the adjustments of the instruments, and for some years past they have varied from about 13,000 to over 17,000 per annum —the tendency being toward an increase. In the majority of shocks the displacement of the stylus is less than 1 mm., representing a rock movement of about 0.01 mm. In a few cases the movement of the stylus is greater, up to, if I remember correctly, about 7 mm. The period of vibration is too short to permit the recording of any wave motion, and the stylus makes a single tick, the length of which is taken as an indication of the violence of the shock.

Of the shocks recorded, about 2 per cent. are reported as having been felt and of these less than 10 per cent. are usually classed as heavy. In other words some 250 to 300 shocks are felt during a year, of which 15 to 25 are classed as heavy. The exact location of the majority of the shocks felt, and of many of the heavy ones, is never discovered; probably they occur in stoped out and abandoned areas.

As to the causes of the shocks, I believe that they are many and varied and that each requires to be examined and discussed on its merits before any sound conclusion can be drawn.

I have defined quakes as fractures or ruptures of pillars or other masses which are called upon to support a superincumbent weight in excess of their limits of endurance. These weights are not due to great depth, but depend upon the extent to which the adjacent support has been removed by stoping operations, while the sudden violence of the shock is a function of the physical constants of the mass of rock involved. I am satisfied that this is a genuine and sufficient cause and that it is unnecessary to conclude that the rock is under any additional stress due to other causes. Such additional (intrinsic) strain may or may not be present in any given case and may add to, or perhaps even detract from, the net result, but it is not an essential feature.

In the case of rock bursts, exactly the opposite would appear to hold good. The cases quoted seem to show that, in places, the rock is in a condition of intrinsic strain which is practically independent of the pressure due to depth or to the removal of support by extensive excavation. The origin of such strains and their sporadic character are undoubtedly difficult problems. Prof. Moore regards them as due to great compressive stresses in former times and considers that the rocks are still under great compression. He suggests that the strains may have been partially relieved, or distributed, by movement, but portions of highly squeezed and strained rock remain which are liable to burst disruptively when encountered in the mine workings. This is practically the view put forward some 16 years ago by Mr. Bosworth-Smith, and I am by no means prepared to deny that such highly squeezed patches may exist.

I am not, however, prepared to admit that these rocks are, on the whole, under great compression at the present time, as asserted by Prof. Moore, and I know of no evidence to support such a view. No doubt they were highly compressed when the schists were folded, as well as after the introduction of the quartz veins which are crashed, faulted and intersected by great faults with slickensided walls. Much of the pressure and movement probably accompanied the intrusion of the Peninsular gneiss in Archaean times, and since Archaean times there is no evidence of pressure or differential movement in the rocks of the State. In Pre-Cambrian times the rocks, both schist and gneiss, were penetrated by a great series of dolerite dykes which traverse them in east and west and north and south directions. The walls of the dykes show no signs of faulting, brecciation or slickensides, and the dykes show no signs of pressure, faulting or folding. It seems probable that the dykes welled quietly into a great rectangular series of contraction rifts due partly to contraction, resulting from the cooling of the great mass of the Peninsular gneiss, and partly to buoyancy which accompanied ex-

tensive denudation. Since that time, denudation has continued uninterruptedly and many thousands of feet of schist and gneiss must have been removed with consequent relief of compression, which would be further relieved by secular cooling and shrinkage as the depth from surface was reduced.

In the absence of any evidence of existing regional compression, it seems reasonable to conclude that the original compression which produced folding, faulting, slickensides, etc. has been largely, though unevenly, relieved. If some portions of rock still remain in a state of squeeze it is open to doubt if they would burst out in large pieces, though some shaling might occur, as in the case of pillars under great weight. If there are residual strains remaining from the period of great compression and folding it is probable that the more important of these are connected with the bending of the more massive layers and local inequalities of adjustment. Parts of the rock will be in tension and parts in compression and the former will be those to give way first and most frequently. There may also be bending moments due to the regional elevation of the Mysore Plateau, though we have no evidence of this at the present time, or there may be a certain amount of stretching due to buoyancy resulting from the removal of a great superincumbent layer. If we add the shrinkage due first to the cooling of large igneous masses of gneiss and later to reduction of temperature from degradation of the surface, there appears to be ample opportunity for the production of tensional strain, which will be locally and variably distributed according to the varying character of the rock layers and the local adjustments previously effected. Such earlier adjustments are suggested by the cross joints filled with calcite and quartz, and present-day adjustments, apart from the rock bursts themselves, are suggested by the frequent tendency of the footwall to loosen itself in large rectangular blocks and the occasional occurrence of fissures in both the foot and hanging walls which show no tendency to close. It may be that the excavation of the mine workings, followed by lowering of temperature due to ventilation or compressed air, is often the last straw which carries the tensile strain past the critical moment.

I have pointed out that these rock bursts occur in the trap dykes and that there is no suggestion or evidence that the dykes have been subject to compression since their solidification. On the other hand, we cannot doubt that they have cooled and contracted and as they are firmly frozen to the enclosing rock it is probable that they are under tension, with a tendency to shrink and rupture when the enclosing envelope is pierced. I do not suggest that the tendency of the dykes to contract produces a condition of tension in the schists, but the fact that rock bursts occur in them suggests that the similar phenomena in the crystalline schists may likewise be due to tensional stresses in spite of the fact

that schists were, obviously, at one time under great compression. I have endeavored to show that the compression of the schists as a whole does not preclude a state of tension in some members, and that there are grounds also for believing that active compression has long ceased and that the rocks have since been subject to contraction and stretching.

In conclusion, I may state that this note has been written while travelling and that figures given are quoted from memory and may be subject to some revision; they are, however, substantially correct. I fear I may have exceeded the customary limits of discussion but I trust that the more recent details which I have been able to furnish may add to the interest and value of Prof. Moore's paper.

Electrostatic Precipitation

Discussion of the paper of O. H. Eschholz, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1293.

Gerard B. Rosenblatt,* Salt Lake City, Utah (written discussion†).—Mr. Eschholz attacks this problem from what appears to me to be the proper angle. He does not limit his viewpoint to the attainment of ideal results under conditions approximating laboratory practice, but rather discusses actual commercial conditions that must be maintained in large-scale operations, where continuity of service without expert attendance is one of the prime considerations.

I am of the opinion that Mr. Eschholz has not given sufficient consideration to the commercial possibilities of what he describes as System B, the use of low-tension a.-c. industrial or lighting circuits for supplying power to Cottrell treaters through the medium of a step-up transformer and a synchronously driven rectifier, without the use of motor-generators. It is true that, to date, few installations on a large scale have used this system, but I believe that when the conditions of power supply are suitable, and when proper precautions are taken, this system can be used successfully and to advantage where at present it is considered necessary to use motor-generator sets.

In the average commercial Cottrell installation of any size, the motor-generator set is used for two purposes:

(1) To isolate the industrial supply circuit from the Cottrell circuit.

(2) To afford an easily operated and smooth system of control for the Cottrell treater voltage.

With proper engineering, both of these objects can be accomplished without the use of motor-generator sets.

---

* Electrical Engineer.

† Received Aug. 19, 1918.

In isolating the industrial circuit from the low-tension Cottrell circuit, the motor-generator set performs two functions; it eliminates or at least damps the effect of irregularities of voltage in the industrial supply circuit upon the voltage of the Cottrell circuit; and it prevents disturbances in the Cottrell circuit from being reflected back to the industrial circuit.

If the voltage regulation of the industrial supply circuit is good, then the first function of the motor-generator set is unnecessary. Many central stations and many of our larger industrial plants, smelters, cement works, and the like, maintain voltage regulation which is altogether adequate for direct supply to the Cottrell transformer. Even if they do not, it may prove in many cases that a small automatic induction regulator of the type commonly used in lighting systems may remedy most of the deficiencies in voltage regulation. It is a matter of balancing dollars and cents to determine whether such a regulator is justified.

As to the reflection of Cottrell-circuit disturbances to the industrial circuit, this also can be guarded against by the proper precautions. The disturbances that are apt to emanate from the Cottrell circuit may generally be classified as follows:

(1) The creation of disturbing harmonics by the parallel operation of synchronously driven mechanical rectifiers, which rectifiers cannot be set so that they make and break contact at exactly the same point in each cycle.

(2) The effect of maintained short-circuits on the high-tension side of the step-up transformer, usually in the treater tubes themselves.

(3) The reflection of high-voltage surges from the high-tension treater circuit to the low-tension side of the transformer.

The harmonics created by the parallel operation of mechanical rectifiers can be cared for in a number of ways. If the total capacity of the supply circuit is large in comparison with the energy taken by the Cottrell system, these harmonics are readily absorbed and cause no trouble whatever. This has been quite definitely brought out by certain oscillograph investigations which have been conducted with an installation of approximately 100 k.v.a. of Cottrell equipment in a western smelter. If, however, it is desirable to absorb these harmonics, it can probably be accomplished by one of several methods, none of which has yet received adequate investigation. One of these methods is to supply a damping winding in the step-up Cottrell transformer. Another is the possibility of using a selective resistor which can be constructed to have very much higher impedance for abnormal frequencies than for the proper operating frequency. Another possibility is a synchronous impedance connected to and operated from the mechanical rectifier. Admittedly, all of these remedies for the absorption of harmonics introduce complications in the circuit, but with proper development it is very pos-

sible that these complications may be reduced to such an extent that, from an operating point of view, they will be negligible.

The effect of maintained short-circuits may be counteracted exactly as in the use of motor-generator sets; that is, by proper mechanical rectifier backed up by adequate circuit-breakers.

The reflection of high-voltage surges is also readily prevented by simple, permanently adjusted, immobile apparatus such as small condensers connected between line and ground, with possibly the addition of a safety spark gap. Condensers are now used for this purpose with most motor-generator installations.

With proper protective equipment, the life hazard mentioned by Mr. Eschholz is certainly no greater when using an industrial circuit supply for the Cottrell transformer than when using motor-generator sets.

The control of treater voltage when using an industrial circuit to supply the Cottrell transformer direct is probably not quite so accurate as when using motor-generator sets, but it is sufficiently fine for many commercial applications, and the advantages of eliminating the motor-generator sets, even at a sacrifice in fineness of control, should certainly receive consideration in many instances.

The maintenance of heavy current through variable resistance contacts is not so serious if the contacts are properly designed and if the voltage difference between adjacent contacts is kept low. It has been found that what burns contacts on the series rheostat, in the low-tension of a Cottrell circuit, is not the current carried by the contacts but the arc formed when the contact arm is moved from one contact to another. Admittedly, this means a rheostat having a considerable but not an inordinately great number of steps.

Under commercial operating conditions, I question whether the power losses would be very different in a system using industrial power supply than in one of individual motor-generator sets. The losses in the series adjusting resistance, and in the synchronous motor for driving the rectifier, probably would average about the same as the combined losses in the motor-generator set, including those entailed in the excitation of the Cottrell generator. Anyway, in a commercial plant, power required for electrical precipitation is a small portion of the expense of operating, and if one system did take 10 per cent. more power than another, it would be difficult to find its effect in the actual cost per ton of dust recovered.

The hazard of plant shut-down, which might be caused by a treater disturbance in case industrial power is used directly on the low-tension of the Cottrell transformer, is the one point that cannot be decided until some large commercial installation, omitting motor-generator sets, is actually made and operated for a considerable period of time. I think that, with proper consideration of the points previously mentioned, this hazard would not be serious.

The foregoing has been mainly confined to the disadvantages charged against the omission of motor-generator sets in a commercial Cottrell installation. The advantages of omitting the motor-generator sets are worthy of mention; they are:

(1) Less space required for electrical equipment.

(2) Less apparatus to buy and care for.

(3) Smoother operation if the power supply has proper characteristics.

(1) Any tentative plant layout will prove the space economy of omitting the motor-generator sets, even considering the increased space required for the switchboard installation and admitting the fact that the rectifier, whether driven from a motor-generator set or a little synchronous motor, occupies a large proportion of the floor area required by all rotating machinery.

(2) The omission of the motor-generator set decreases the first cost of the apparatus but, as well pointed out by Mr. Eschholz, electrical apparatus is the small end of the first cost of the treater, and I would not lay too much stress on a slight reduction in first cost of electrical apparatus. The matter of maintenance and attention is of somewhat more importance, and I think that it will be found that maintenance of rheostat contacts and synchronous motor bearings will be less than that of motor-generator sets with collector rings and with exciters having commutators. However, the actual cost of maintenance, in dollars, may not differ greatly because an attendant is necessary in most Cottrell installations, and he usually has spare time to devote to keeping any *simple* design of machine in good shape. I believe, however, that shutdown due to machine trouble will be probably less if motor-generator sets are eliminated.

(3) The question of smooth operation if industrial power supply is used direct for the Cottrell transformers depends entirely on the characteristics of that supply. If the wave form is right, if the voltage regulation is good enough, and if the capacity behind the plant is sufficient, experience has shown that smooth operation in the Cottrell treater follows. If these conditions do not exist, then operation with industrial power supply will be very much more troublesome than if motor-generator sets are used. For this reason, the elimination of motor-generator sets from the installation for a Cottrell treater cannot always be properly recommended; I contend merely that in many places industrial power could advantageously be used direct.

In any event, for a commercial installation, either the motor-generator set with mechanical rectifiers and step-up transformers, or industrial power supply direct to the step-up transformer with synchronously driven mechanical rectifiers, would seem far more satisfactory than any system which, in order to eliminate the mechanical rectifier, introduces intricate and as yet not thoroughly developed electrical equipment. If the Cot-

trell process is installed in a plant to make money from the product recovered, then the apparatus used must be of the simplest, most rugged, and most highly developed type.

The Byproduct Coke Oven and Its Products

Discussion of the paper of W. H. BLAUVELT, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, pp. 597 to 614.

A. K. McCOSH, Coatbridge, Scotland (written discussion*).—It is well known in Great Britain that oven operators in the United States have been able to reduce the coking time much below European standards by the employment of higher temperatures. Our linings have always been the factor that has prevented our doing the same, and it would be of much interest to coke-oven operators here if Mr. Blauvelt would give a typical analysis of the bricks his company uses for the linings of its ovens, and if he could see his way to send me a sample so that I could have the texture examined, I should personally be very much obliged.

The lining brick which my company has found most successful is of a ganister variety, and has the following analysis: Silica, 80.8 per cent.; alumina and iron oxide, 17.8 per cent.; lime, 0.8 per cent.; magnesia, 0.07 per cent.; but with this brick the least carelessness on the gas regulator's part may destroy the lining.

It would also be of interest if Mr. Blauvelt could give the temperatures of the air leaving these generators and also of the oven flues.

I should be glad to know the life of the linings operated at these high temperatures. I have known oven linings to last as long as 10 years, and, in our case, if any lining fails before the end of seven years we consider that it has done badly. This is with washed coal containing about 12 to 15 per cent. of free moisture, and charged by compressing machines.

As regards the size of ovens, the width and lengths given by Mr. Blauvelt are much the same as in this country, and the additional capacity is obtained by increasing the height. At a great number of the plants on this side, the coal is compressed before charging, and the maximum height of the charge is about 7 feet.

It would be interesting to know whether compressed charges are ever used in America and whether you find it feasible to compress a charge for an oven 12 ft. high.

Has the construction of ovens longer than 36 ft. ever been considered, and what is thought to be the limiting factor in this dimension?

---

* Received Sept. 3, 1918.

Possible Existence of Deep-seated Oil Deposits on the Gulf Coast

Discussion of the paper of A. F. LUCAS, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 139, July, 1918, pp. 1119 to 1134.

G. SHERBURNE ROGERS,* Washington, D. C. (written discussion†).—We are indebted to Captain Lucas for an interesting contribution to the literature of the salt-dome oil fields, and especially for his suggestion that a more aggressive method of prospecting be adopted. The occasional discovery of new fields on the Gulf Coast is in itself sufficient to show that the oil possibilities of the region are by no means exhausted, and those who have studied the area most thoroughly are the most optimistic regarding its future. Nevertheless, the search for new fields, according to present methods, involves the expenditure of great sums of money annually, for the proportion of dry holes to producing wells drilled yearly in the Gulf Coast region is much greater than in most areas, even if all the wells drilled in what is commonly regarded as proved territory are included. Not only are the present methods of locating new domes very uncertain, but when a dome is discovered there is no assurance that it will be oil-bearing; or, if so, whether the oil occurs in the cap-rock, in the sands above it, or in some small isolated lens of sand far down on the flanks of the salt mass. As Captain Lucas points out, about all we positively know is that the domes are there and that some of them are oil-bearing; their origin is a matter of controversy and the original source of the oil is conjectural. Under these conditions, it is not surprising that the search for oil is conducted more or less blindly and that dry holes are common.

Many wells are drilled each year in an endeavor to find oil at depths of 2000 or 3000 ft. (609 to 914 m.) or less, in locations which most geologists would condemn without hesitation. As Captain Lucas suggests, the money spent in this way might be used to far better advantage in drilling one deep well in a carefully selected locality. Opinions may differ as to whether such a well would find oil, and many geologists will probably believe that the chances are against it, yet all will agree that the boring, whether it finds oil or not, will probably throw light on the origin of the domes and on the source and mode of accumulation of the oil, and will therefore be of great interest, not only to the scientist, but to the oil operator.

Our opinion of the chance that a deep well would have of finding new reservoirs of oil depends on our conception of the origin and course of migration of the oil. I cannot concur in Captain Lucas' belief that the domes are due directly to volcanic activity, and that the oil is of inorganic

* Geologist, U. S. Geol. Survey.

† Received Sept. 3, 1918.

origin. In my opinion, the facts indicate that the salt has been squeezed up under the influence of pressure from deep-seated salt beds and that the domes are themselves salt plugs or laccoliths rather than the product of igneous plugs or laccoliths below.[1] According to either view, however, or to any of the numerous other theories extant, it is evident that a line of communication, or at least of weakness, exists between the general horizon at which the oil is now found and very much deeper and older beds.

Most geologists agree that the oil did not originate in the beds in which it now occurs, and believe that it has migrated up from the older strata. Many, however, consider that the migration has been a short one, and at Humble, for example, there is a good reason to believe that the oil originated in the lower Tertiary Yegua formation which immediately underlies the deep oil sands. On the other hand, there are several horizons in the Cretaceous which are petroliferous in northern Texas and Louisiana, and the Carboniferous horizons of the Mid-continent field are, of course, extremely rich. Cretaceous rocks are known to underlie the salt-dome region, and there is every reason to suppose that Carboniferous formations are also present; whether or not these formations contain oil is, of course, conjectural. If they ever were petroliferous in this region the oil must either have ascended along the salt core and collected on the salt domes or in some convenient reservoir en route, or it must still be present in the deeper formations today.

It might be argued that the pressures and temperatures to which the lower Cretaceous and Carboniferous rocks are now subjected would have resulted in the cracking and destruction of whatever oil they may have contained. It appears, however, that unless the gaseous products of cracking are permitted to escape the process goes on only until an equilibrium is reached and that complete conversion of oil into gas and residuum would be attained only at far higher temperatures and pressures than would prevail. In the Ventura County fields (California), oil is now produced from the Topa-Topa formation, which apparently was at one time buried under more than 20,000 ft. (6096 m.) of sediments; and in some of the Wyoming fields, also, oil is produced from horizons that were formerly deeply buried. We do not know the greatest depths at which oil can exist, but they are certainly below levels yet reached by the drill.

The enormous quantity of oil per acre that has been produced at Spindletop suggests that either salt has a mysterious faculty of attracting oil from the sediments, as some European geologists believe, or that the gathering area is greater than would appear, or that some of the oil has ascended from unknown reservoirs below.

The occurrence of gas and oil in the salt at Belle Isle, as described by

[1] I have discussed this view in a paper entitled, "Intrusive Origin of the Gulf Coast Salt Domes," which will appear in the next number of *Economic Geology*.

Captain Lucas, is an indication of deep oil deposits in that locality. Belle Isle is flanked by a great thickness of Pleistocene sediments and the oil encountered at 3000 ft. is very possibly Tertiary oil that has migrated into the salt, though, on the other hand, it may have been driven from older beds and may have migrated some distance vertically.

Nothing is known regarding the shape of the stem or lower portion of the salt cores, or of its structural relations with the surrounding sediments. Whether oil (if present) could be retained in porous strata abutting against the salt, or whether conditions are such that it must have migrated upward, is a matter for speculation. In the writer's opinion, most of the salt cores probably incline up to a laccolithic or mushroom shape, and if so, a well starting on the dome and penetrating salt might pass out of the salt and into sediments lying against the stem of the salt core in such a way as to form excellent reservoirs. These matters can, of course, be settled only by drilling, and estimates of the chance of finding oil in a deep well must, in view of our present lack of knowledge, be based largely on personal opinion or conjecture. As more accessible possibilities are becoming exhausted, the question of deep drilling is becoming increasingly attractive. If a deep well finds oil at all, it is likely to discover rich reservoirs and will pay for itself indirectly through the light it will shed on the unsolved problems of the Gulf Coast oil fields.

Oil in Southern Tamaulipas, Mexico

Discussion of the paper of Ezequiel Ordoñez, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 137 (May, 1918), page 1001.

V. R. Garfias,* Palo Alto, Cal. (written discussion†).—Regarding the statement of Mr. Ordoñez, on page 1007, concerning the synclinal curving of sedimentary beds caused by the extrusion of volcanic necks, that "this phenomenon might occur, but it is not fully proved in our fields," I beg to reply that the funnel and anticlinal-ring structure *is actually associated* with igneous intrusions in the Mexican oil fields, as we were able to ascertain by plotting an underground contour map and making a structural model of the oil-bearing beds of the Ebano field.

E. De Golyer, New York, N. Y. (written discussion‡).—The paper under discussion is not only of interest in connection with its subject but it is a contribution of considerable importance to our knowledge of the possible effect of igneous rocks upon the accumulation of petroleum in the Mexican fields.

---

* Geologist and Civil Engineer.

† Received Aug. 19, 1918.

‡ Received Sept. 6, 1918.

Señor Ordoñez[1] has long held that the intrusion of igneous rocks in the Mexican fields has had no important structural effect in the accumulation of petroleum and does not seem to have found it necessary to change his opinion because of his studies in Tamaulipas.

Clapp,[2] as a result of his most recent consideration of the Mexican fields, has concluded that:

> At the base of the upheavals (around the plugs) and surrounding them in close proximity the Tamasopo limestone and overlying formations form pockets or places of catchment where large deposits of oil have accumulated. In the Tamasopo limestone and the San Felipe beds these oil deposits were presumably concentrated from surrounding portions of the same strata, owing to the upheavals mentioned; possibly with the assistance of heat.
>
> The presence of the oil accumulations surrounding the plugs is sometimes, although not always, evinced by large seepages of oil. Some cases are known where the lower beds actually reach the surface and a true quaquaversal structure exists. Whether this is common has been doubted, but it is certain that definite doming does exist surrounding some of the plugs. At any rate, it is a fact that where the plugs exist pockets of oil have accumulated, and the conical plugs themselves may be considered as quaquaversal structures.

Garfias and Hawley,[3] following and developing the theory advanced by Garfias[4] in 1912, apparently largely as a result of his observation of wells in northern Alazan and a consideration of the analogy suggested by driving a nail through a book, have tried to find in the action of the intrusion a reason for the common occurrence of oil in the vicinity of igneous plugs in Mexico. They propose a theory of a circular anticlinal ring and funnel structure surrounding igneous necks and argue by analogy, citing numerous sections and examples of such structure, though they fail to cite any Mexican occurrences, merely concluding that there is no "question of the existence of these conditions in the Mexican fields."

I have long held with Ordoñez that important occurrences of petroleum in the Mexican fields, under the conditions described by Garfias and Hawley, and by Clapp, have not yet been proved to exist and, although I am not yet prepared to accept wholly the Ordoñez theory that the "roots of the plugs of lava, ramified like those of a plant, have served as channels to bring the mineral oil to the hollow or porous spaces prepared during the appearance of the lava plugs," I agree that one important effect of the intrusions has been the formation of pore space by breccia-

---

[1] Sobre Algunos Ejemplos Probables de Tubos de Erupcion. *Memorias* Sociedad Cientifica "Antonio Alzate" (1904–05), **22**, 141–150. The Oil Fields of Mexico. *Trans.* (1914), **50**, 859–863.

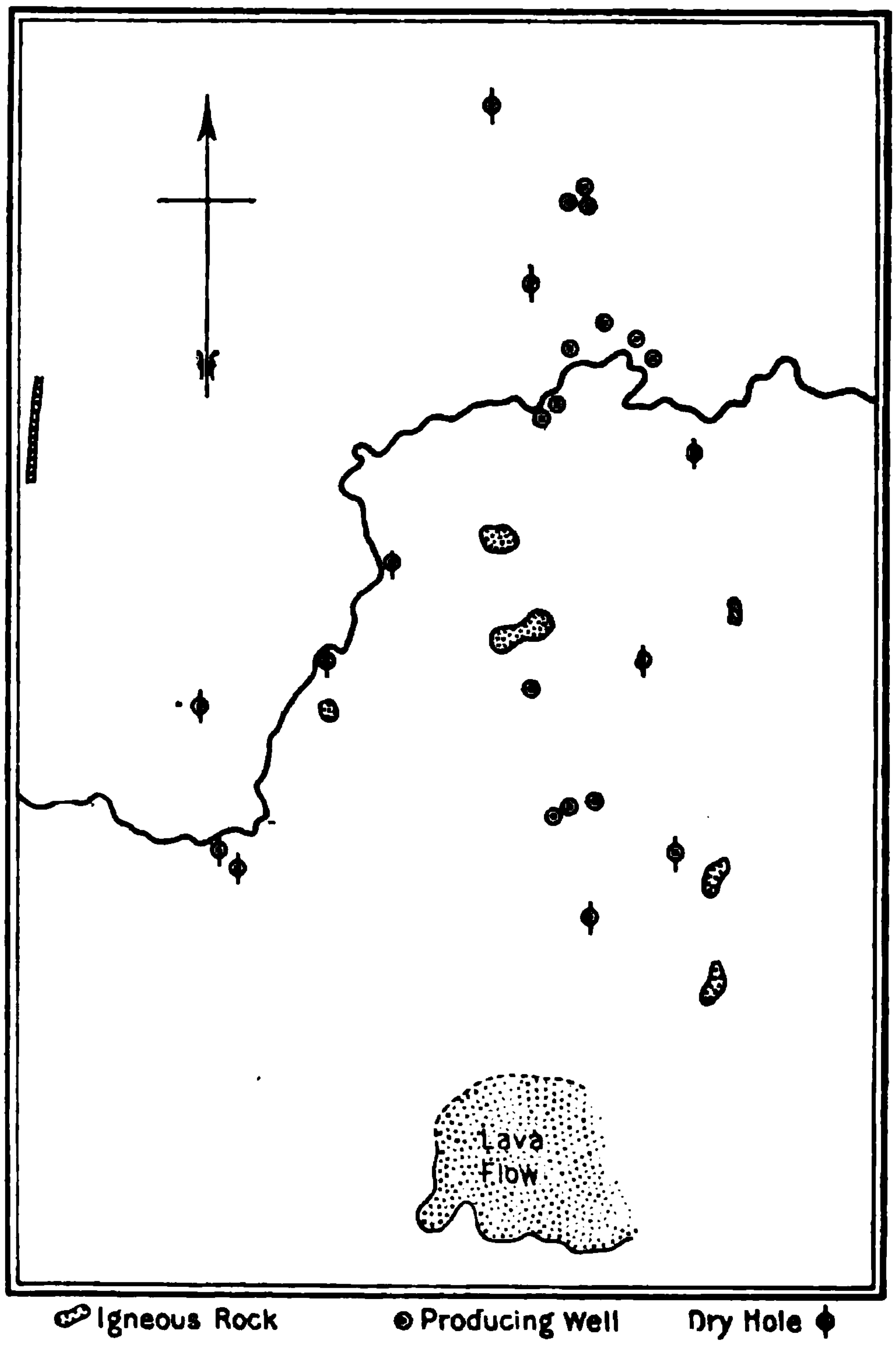
[2] Revision of the Structural Classification of Petroleum and Natural Gas Fields. *Bull.* Geol. Soc. America (1917), **28**, 586.

[3] *Trans.* (1917), **57**, 1071–1032.

[4] The Effect of Igneous Intrusions on the Accumulation of Oil in Northeastern Mexico. *Jour. of Geol.* (1912) **20**, 666–672.

tion and metamorphism. I have further suggested that the greatest importance of the porous zones thus formed is that they cut across the sedimentary strata and so provide for transverse migration of petroleum.

The accompanying sketch of the Tepetate-Casiano pool, showing the surface relation of the outcrop of igneous rock[5] to producing wells and dry holes, is instructive in this connection, since the region is one of considerable igneous activity. No evidence of doming similar to that suggested by Clapp, nor of anticlinal ring and funnel structure similar to



SKETCH MAP OF TEPETATE-CASIANO OIL FIELD.

that suggested by Garfias and Hawley, has yet been seen in this field. In the sketch, only those wells which have been completed to the Tamasopo limestone are shown. The occurrence of the deeper dry holes or salt-water wells on both flanks, and of shallower producing wells along a narrow, unbroken, N.-S. striking zone are the distinctive features of this field as thus far developed by exploration. The surface geology does not show a marked fold corresponding to the ridge in the Tamasopo limestone that is shown by drilling operations. The structure has been ten-

[5] Igneous rocks mapped by C. W. Hamilton.

tatively explained as being the result of folding which started in the Tamasopo before the deposition of younger rocks. The strike of the field parallel to that of the dyke to the west and parallel to the line of weakness shown by the three domes or dyke outcroppings to the east of the field indicate that faults, the existence of which cannot be determined at the surface because of the lack of good rock exposures, may have been the controlling factor in determining the structure of this field, one of the most important in Mexico.

A few kilometers to the south is another important field, the Los Naranjos, in which the discovery well was located by the writer. This field is a broad dome; the producing wells are located on its crest, and the only known igneous rocks consist of a dyke on the south flank and another on the eastern flank.

The oil industry is to be congratulated in having a clear recognition, by so distinguished a Mexican as Señor Ordoñez, of the preliminary preparation and the risks incident to exploratory drilling. Attention was early attracted to the petroleum seepages of Tamaulipas, and particularly to those of the San José de las Rusias region. In 1864, permission to exploit petroliferous substances at San José de las Rusias and at Chapopote, near Aldama, were granted to a certain Ildefonse Lopez, and similar permission was granted in 1865, to one Parades to exploit *chapopote* at Carancitos.

In 1873, Alajandro Prieto in his book, "Historia, Geografia, y Estadistica del Estado de Tamaulipas," describes the profusion of *chapopote* seepages in southern Tamaulipas and concludes (p. 264): "This class of product, which is encountered in such abundance in Tamaulipas, should form some day, by itself alone, a branch of industry which will doubtless offer greatly to the prosperity of these communities."

In 1889, a well was drilled to a depth 40 m. near San José de las Rusias by a certain Manuel Flores and is said to have gushed oil.

The oil field department of S. Pearson & Son, in 1907, commenced drilling near Los Esteros in southern Tamaulipas and completed four wells before abandoning the enterprise as unproductive. Subsequently the American International Fuel and Petroleum Co. drilled 8 wells in the same region. In 1909–1911, the Tamesi Asphalt and Petroleum Co. drilled two wells near the same place. All of these wells were unsuccessful. In 1913, Tampico Oil, S. A., drilled a dry hole near Jopoy, on the Tampico River.

In 1910, the Texas Mexican Asphalt and Petroleum Co. moved a small drilling machine to the San José de las Rusias property and drilled a number of shallow wells, none of which was successful. Finally, a standard rig was brought in and a shallow well was drilled at a seepage rising along a dyke near Encarnacion. The rig was moved a short distance and a well was drilled to a depth of 2274 ft. (690 m.) and abandoned.

The Corona Petroleum Co. (Royal Dutch-Shell group) then became interested, took over the lease and, after careful surveys by competent geologists, commenced drilling in 1914. To date, they have completed and abandoned as dry holes five wells having depths of 3450, 4000, 3496, 3030 and 3370 ft. (1052, 1219, 1066, 924, 1027 m.) respectively, and are now drilling two other wells.

During the past year, the Mexican Gulf Oil Co. completed and abandoned as a dry hole, at a depth of 3280 ft. (999 m.), a well on the Sabino Gordo property near Chapopote, just south of Aldama. This well was drilled near a seepage at a small hill of rock metamorphosed by igneous intrusions, and resulted in a salt-water well.

It is quite probable that in the purchase of leasehold, drilling of unproductive wells, and for various incidentals in an unsuccessful attempt to develop a productive oil field in the State of Tamaulipas, as much as a million dollars has already been expended, most of it under competent technical direction. The region has been recognized as probable oil territory since the earliest time and yet not a single commercially productive well has been encountered. Nor has it been proved that the State will not be an important oil producer at some future date. The conclusion reached in the paper under discussion that "even the good Mexican oil lands, far from the centers of actual exploitation, to become productive require assiduous and detailed geological studies, drilling and exploration, implying a considerable investment" would seem to be irresistible.

Crushing Resistance of Various Ores

Discussion of the paper of LUTHER W. LENNOX, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, pp. 1255 to 1264.

C. Q. PAYNE, New York, N. Y. (written discussion*).—The method adopted by Mr. Lennox is a very interesting test of the practical application of Mr. Gates' crushing-surface diagram to a great variety of gold and copper ores. His method of dealing with the material below 200-mesh is also a distinct contribution to the subject, although, as he suggests, it seems likely that some microscopic measurement of this material may be advisable before the mesh reciprocals of its group particles can be dealt with as accurately as can those coarser than 200-mesh.

In examining the general results shown in Table 3, it is somewhat puzzling to perceive why Calumet & Hecla jig tails should show a crushing resistance 3½ times greater than that of the ore from the Ray Consolidated copper mine. The latter is, I believe, an altered Pinal schist

* Received Sept. 3, 1918.

containing over 70 per cent. silica, and the composition of the former probably does not differ greatly in this respect. I also note that the crushing resistance of Calumet & Hecla jig tails compares with that of Miami ore in the ratio of about 2 to 1. Hardinge mills are now being employed to crush Calumet & Hecla conglomerate, and also Miami ores on a very large commercial scale, and it is interesting in this connection to note that M. K. Rodger's[1] gives the relative crushing duty of 1 hp. on C. & H. conglomerate and Miami ore as 1 : 3.75, the feed in both cases being ¼-in. size. The inverse of the above figures would represent the relative crushing resistances. At a later date Mr. Gates[2] pointed out that the crushing-surface diagrams of the two ores, on material coarser than 200 mesh, give for C. & H. conglomerate 12.5, and for Miami 34.0 mesh-tons per hp.-hr. This would indicate the relative crushing resistance of these ores to be 2.72 : 1. However, this difference in the crushing resistance of these two ores, as measured by Mr. Lennox's small tube-mill and by the Hardinge mill may be due to the fact that the crushing-surface diagrams in the two cases are not comparable.

A possible question in connection with these tests is whether the determination of the crushing resistance of an ore may not be difficult to measure owing to what may be called "screen resistance." Of two ores which may have the same crushing resistance when measured by a 4- or 8-mesh screen, for example, one may show a much greater crushing resistance than the other when measured by a 200-mesh screen, owing to the presence of a certain amount of mica or other flaky mineral unlocked at, say, 50 mesh, but only reduced to pass a 200-mesh screen by very prolonged grinding. The micaceous ore would thus show a different crushing-surface diagram from the granular ore, although the same amount of energy might have been expended in crushing it. The proximity on the scale of crushing resistance (Table 3) of such a hard and tough ore as the Homestake to a comparatively soft ore like that of the Nevada Consolidated for example, has suggested the idea that a difference in the "screen resistance" might perhaps here have counteracted a greater difference in the crushing resistance than the results actually show.

The interesting and valuable work done at McGill University by Professor Bell seems clearly to establish Rittinger's law as a better measure of the energy absorbed in crushing than Kick's law. The method of recording the work of crushing by the crushing-surface diagram, which has been developed and illustrated by Mr. Gates, also marks a very notable contribution to the subject. The crushing-surface diagram is fascinating from its very simplicity. But are we not expecting too much from it until we have corroborated it, and perhaps corrected it,

---

[1] *Trans.* (1915), **52**, 944.

[2] *Min. and Sci. Pr.* (Mar. 11, 1916), **112**, 366.

by means of certain more exact physical measurements on a wide range of minerals and ores? Many ores consist of a more or less loose aggregate of different minerals, and it may help toward clear thinking if we subdivide the subject, and apply the laws of crushing only to the breaking up of aggregates, as performed by coarse crushing, in which surface areas can be accurately measured by screen analysis; and then apply the laws of grinding to the reduction of small-sized particles of homogeneous composition, the surface areas of which are difficult to measure by screen analysis alone.

For illustration, if we knew the number of heat units developed, and therefore the energy absorbed, in grinding 100 gm. of a given ore or mineral, so that it would all pass a 200-mesh screen, could we not then develop an energy unit which would be a physical constant for that particular ore or mineral? With a number of such physical constants determined for various ores, we would then have more accurate means of measuring not only the grinding resistance of the ores, but also the mechanical efficiencies of different machines employed in grinding them. Such an energy unit as I have suggested might require some other method than screen analysis to estimate the surface exposed; since the unit should be independent of the habit of crystallization of the component ore minerals, and should be directly related to their molecular structure, on which their coherence and mechanical resistance to grinding must ultimately depend.

The establishment of accurate methods for measuring the energy absorbed in crushing and grinding ores is a matter of great importance. Most mining engineers realize the backward state in which the art of crushing now lies, largely for lack of accurate units of measurement. Considering the subject broadly, and including the crushing of cement rock and clinker and pottery materials, it is probable that the average efficiency of crushing as a whole does not exceed 20 to 25 per cent. When we recall that the efficiencies reached in the concentrating, cyaniding, and flotation of ores frequently exceed 90 per cent., it is evident that the first step in the ore-dressing and allied industries is worthy of more serious attention than it has yet received.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the Milwaukee meeting, October, 1918, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Nov. 1, 1918. Any discussion offered thereafter should preferably be in the form of a new paper.

The Action of Reducing Gases on Hot Solid Copper

BY NORMAN B. PILLING,* M. S., PITTSBURGH, PA.

(Milwaukee Meeting, October, 1918)

The deleterious effect on the mechanical properties of copper, resulting from heating in contact with reducing gases, is well known, but the mechanism of the action does not appear to have been definitely established. The purpose of the present investigation was not to determine the exact variations in physical quality of commercial copper, with its various impurities, as dependent upon the composition of the gas, temperature of exposure, etc., but rather to study the nature of the action and the conditions under which it occurs.

The physical result of the so-called "gassing" of copper has been generally described as the development of "brittleness." There appears to be a striking decrease in tensile strength, associated with a considerable loss of ductility, and a small copper strip or wire affected in this way can be snapped in two when bent. Larger articles may have an outer layer alone affected, which can be detached from the core by hammering or bending.

Perhaps the earliest reference to this subject is that of Heyn[1] in 1900, and among the later observers may be mentioned Archbutt,[2] Bengough and Hill,[3] Johnson,[4] Mathewson and Thalheimer,[5] and Ruder.[6] Bengough and Hill, while working with arsenical copper, were the first to suggest the possibility of the formation of gases within the copper itself, while Ruder endeavored to explain the action by the reduction of the

---

* Metallurgist, research laboratory, Westinghouse Elec. & Mfg. Co.

[1] E. Heyn: Die Umwandlung des Kleingefüges bei Eisen und Kupfer durch Formänderung im kalten Zustande und darauf folgendes Ausglühen. *Zeit. Ver. Deut. Ing.* (1900), **44**, 508.

[2] L. Archbutt: Determination of Oxygen in Copper. *Analyst* (December, 1905), **30**, 385.

[3] G. D. Bengough and B. P. Hill: Properties and Constitution of Copper-arsenic Alloys. *Jour.* Inst. Metals (1910), **3**, 34.

[4] F. Johnson: A Method of Improving the Quality of Arsenical Copper. *Jour.* Inst. Metals (1913), **10**, 275.

[5] C. H. Mathewson and E. M. Thalheimer: Comparisons between Electrolytic Copper and Two Varieties of Arsenical Lake Copper with Respect to Strength and Ductility in Cold-worked and Annealed Test Strips. *Trans.* (1916), **55**, 446.

[6] W. E. Ruder: The Brittleness of Annealed Copper. *Trans.* Am. Electrochem. Soc. (1916), **29**, 515.

cuprous oxide, leaving a spongy mass having little mechanical strength. The possibility of a direct action of the hydrogen on the copper, forming hydrides, has received but scant support. Quantitative measurements of the effect of the action on the strength and other properties of electrolytic and arsenical copper may be found in the papers by Bengough and Hill, and Mathewson and Thalheimer, cited above.

For the sake of simplicity, attention has here been confined mainly to commercial-conductivity copper, non-arsenical, with 0.05 per cent. oxygen, and about 0.015 per cent. lead. A preliminary study of the effects of reducing gases on hot copper was made by passing the desired gas over a length of soft copper strip heated in an electric furnace. After 30-min. exposure to hydrogen at 800° C. there was a marked deterioration in the quality of the copper. Whereas initially it was quite ductile and resistant to bending, after this treatment it was extremely weak and friable, as evidenced by its inability to withstand even slight bending.

After similar treatment in natural gas and in carbon monoxide, the same phenomenon was observed, but the deterioration was less strongly marked with the latter gas. Similar treatment in an atmosphere of steam caused no observable change in physical quality.

The microscopic appearance of the copper before treatment is shown in Fig. 11; it is homogeneous, with a uniform distribution of Cu_2O particles. After heating in hydrogen, it has become very porous (Fig. 12), each Cu_2O particle has been replaced by a void and, in addition, there are large angular cracks which, as shown by etching, follow the grain boundaries. This observation agrees with the micrographs given by previous investigators. The copper samples heated in natural gas and in carbon monoxide were similar in appearance, but the action was less marked. In no cases could unreduced grains of Cu_2O be detected.

Physical Effect of Hydrogen on Copper

From the results of preliminary experiments, hydrogen seemed to be the most active of the several reducing gases tried, and it appeared likely that in a mixture of such gases hydrogen would play the predominant part. It is likely that any hydrocarbons present would decompose at the temperatures used, and the action would be traceable to the simple gases formed (H, CO, etc.).

The physical effect of heating copper in contact with hydrogen was studied with a number of copper strips, 5/8 by 0.048 in. (15.9 by 1.2 mm.). The oxygen content of this copper was 0.05 per cent. and the material, received in a dead soft condition, showed satisfactory physical properties. These strips were electrically heated at various temperatures in a small tube furnace, evacuated to prevent excessive oxidation, and after the desired temperature had been attained, as measured by a small Pt-

PtRh thermocouple lying at the center of the piece, hydrogen was admitted and passed through the furnace tube over the strip for 30 min. At the end of that time the strip was withdrawn and cooled in the air. A rough measure of the effect of this treatment was made by noting the number of 180° bends over a radius of about ¼ in. (6.3 mm.) the strip would stand before breaking. The effect of complete hydrogenation is so marked that this was found to be a sufficiently sensitive test, though giving comparative values only. The following table gives the results obtained, which are plotted in Fig. 1.

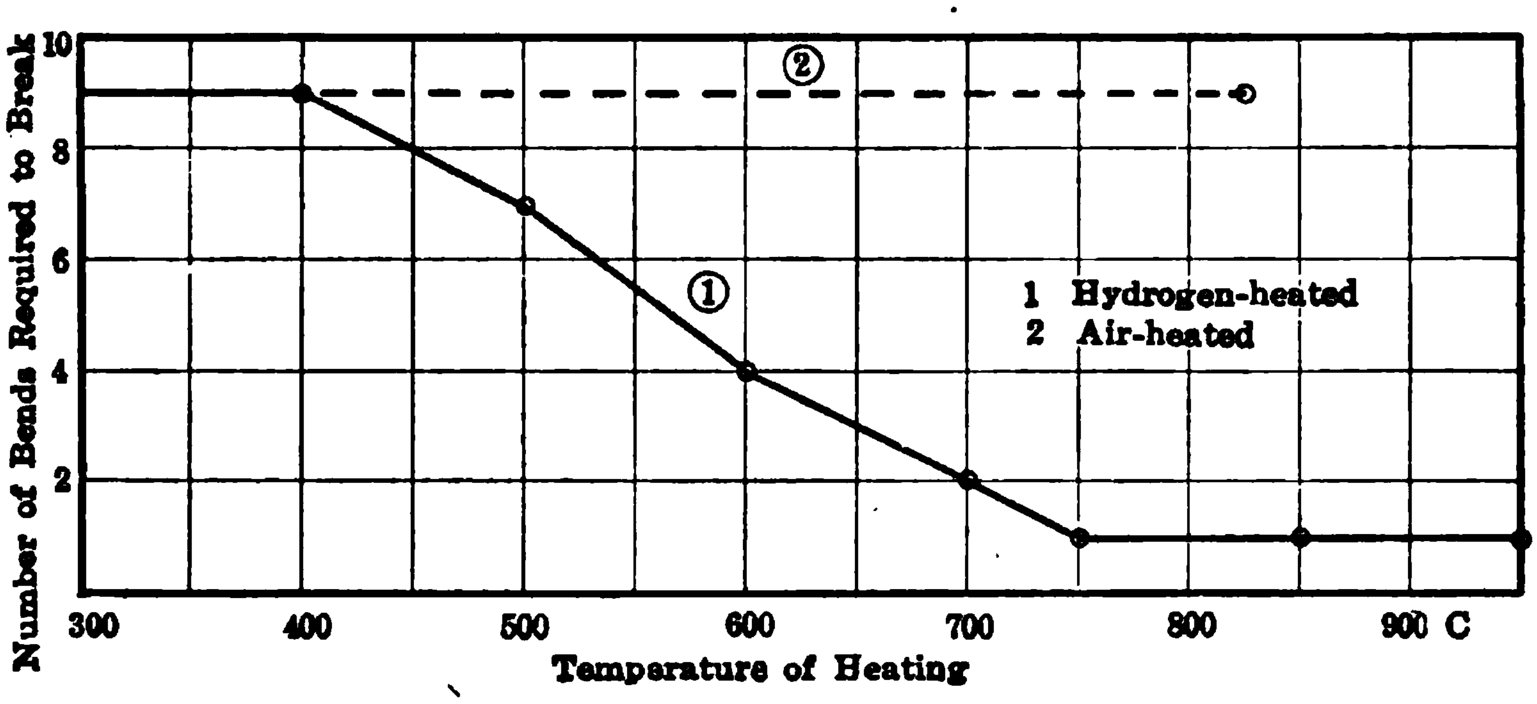


FIG. 1.—EFFECT OF HYDROGEN ON COPPER STRIPS.
(Length of heating, 30 min.)

TABLE 1.—*Effect of Heating Copper Strips in Hydrogen*

Temperature	No. Bends to Break	Temperature	No. Bends to Break
(As received)	9	750°	1
400°	9	850°	1
500	7	950	1
600	4	1050	1
700	2		

That this deterioriation in quality was due to the hydrogen and was not an annealing effect was shown by heating similar strips at 400° and 800° in air (reduced pressure), after which no change in tenacity could be observed.

It will be noticed that the deterioration starts between 400° and 500° C.—well below a red heat—and increases in severity as the temperature of heating becomes higher. An idea of the rate at which this action takes place may be obtained from Fig. 2, in which the bending qualities, after exposure to hydrogen for varying lengths of time at 800° are plotted. In 10 min. the deterioration is complete.

Typical examples of the structures encountered after hydrogenation are shown in Fig. 12 and 13.

Nature of Hydrogenation

The mechanism of the action during exposure of copper to hydrogen appears to be as follows: Commercial-conductivity copper contains various impurities, all, except oxygen and occasionally lead, being measured in thousandths of a per cent. Oxygen normally occurs from 0.03 to 0.08 per cent. in the form of Cu_2O mechanically mixed with the metallic copper. The presence of this quantity of Cu_2O seems to be necessary, in order to avoid the reduction of metallic impurities in the slag from the oxidized to the metallic condition, during refining, and to promote soundness in casting. If hydrogen is physically soluble in solid copper at high temperatures, this gas would penetrate the metal, attack and re-

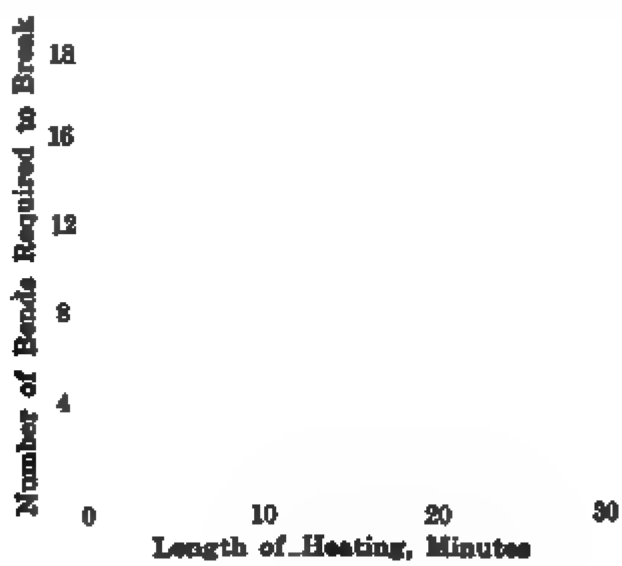


Fig. 2.—Effect of hydrogen on copper strips at 800° C.

duce the grains of Cu_2O, with the formation of steam, according to the equation

$$Cu_2O + H_2 = H_2O + 2Cu.$$

After this reduction, the volume of the copper is but 60 per cent. of the volume of the Cu_2O from which it was reduced, thus leaving voids marking the site of the original oxide granules and approximating 40 per cent. of the space formerly occupied by them.

If steam is physically less soluble in copper than hydrogen, it will accumulate in these pockets at a rate faster than it can dissolve in the copper and diffuse away, and the net result of the reaction would be the formation of a quantity of steam within the voids left by the Cu_2O, and at considerable pressure. A rough calculation of the magnitude of the pressure possible at 800° C., assuming the steam to be completely insoluble in the copper, showed that 8000 to 9000 atm. would develop

if there were no yielding in the copper. The investigations of Bengough[7] on the tensile properties of copper at high temperatures have shown that as the temperature rises the tensile strength falls off rapidly until a "mechanical critical temperature" is reached between 600° and 750° C., varying apparently with the nature and quantity of impurities present. Above this temperature the tensile strength diminishes linearly to zero at the melting point, and in this range the copper is characterized by extreme intercrystalline weakness. Now the combination of considerable internal pressure (steam), with lack of intercrystalline cohesion, forces the grains apart until relief is obtained (see Fig. 18). Deoxidation alone cannot account for the weakness developed, for it is not clear why the substitution of a small void for a small particle of very brittle cuprous oxide should weaken the surrounding metal. A careful examination of copper strips heated at 800° in hydrogen showed that a mechanical swelling takes place coincident with the formation of intercrystalline ruptures. The strip increased in thickness by 4 per cent. and in width by 1.5 per cent. while decreasing about 4 per cent. in density. This decrease in density is not due solely to voids left in the metal by the reduction of the cuprous oxide, as the decrease noted was 130 times as great as the observed loss in weight due to removal of oxygen. The resultant weakness of the copper after this action is due simply to the absence of mechanical coherence between individual grains within the puffed copper.

Permeability of Copper to Hydrogen, Steam, Carbon Monoxide and Carbon Dioxide

In order to verify the explanation given for the "puffing" of copper, the relative permeabilities of several reducing gases and their oxides were determined. The method employed was to observe the change in pressure within an evacuated thin-walled copper tube heated in an atmosphere of the gas in question, in a nichrome-wound quartz-tube furnace. The copper tube extended throughout the length of the furnace, one end of it being pinched and sealed with solder, and the other waxed to the glass vacuum system. An optical-lever manometer[8] was used to measure the slight increments in pressure over the initial pressure (5 mm.), and by reducing the volume auxiliary to the copper tube to the least possible amount, a sensitive arrangement was obtained. In

[7] G. D. Bengough: A Study of the Properties of Alloys at High Temperatures. *Jour.* Inst. of Metals (1912), **7**, 123.

G. D. Bengough and D. Hanson: Tensile Properties of Copper at High Temperatures. *Jour.* Inst. of Metals (1914), **12**, 56.

[8] A modification of that described by J. E. Shrader at the Pittsburgh meeting of the Am. Physical Society, Dec., 1918.

use, both the copper tube and the enclosing furnace tube were evacuated until a steady temperature was reached, measured with a small Pt-PtRh couple adjacent to the copper tube, and then the desired gas was introduced, flowing slowly through the quartz furnace tube at atmospheric pressure. This arrangement is shown in Fig. 3.

The hydrogen and carbon dioxide were taken directly from pressure tanks; the carbon monoxide was generated by the action of sulphuric and formic acids, the gas being dried before entering the furnace; the steam was introduced wet at atmospheric pressure.

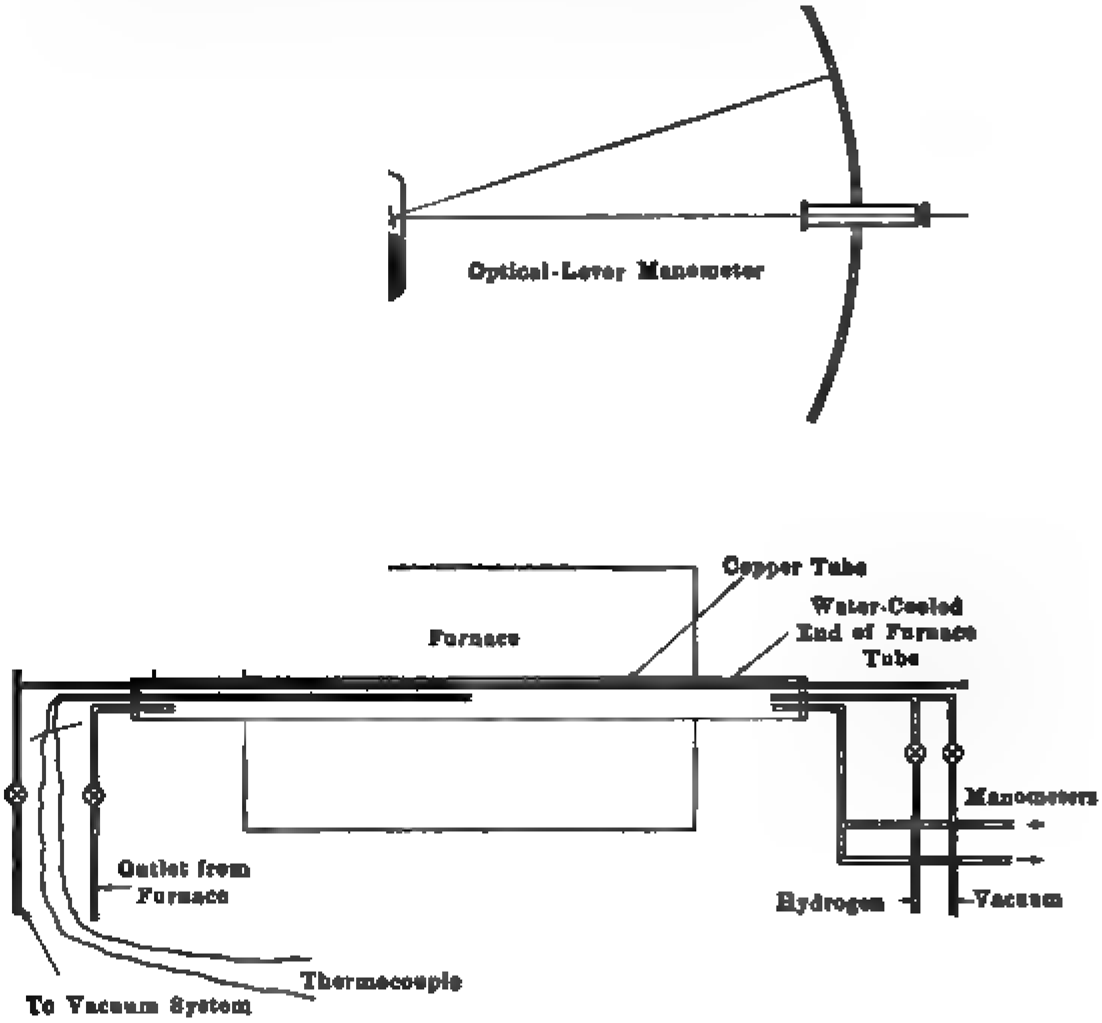


FIG. 3.—ARRANGEMENT OF APPARATUS.

After some experimentation, 700° C. was chosen as a temperature suitable for making measurements of the comparative rates of diffusion of these gases through copper. Curves giving the observed change in pressure inside the copper tube, due to diffusion of the gases through its walls, are shown in Fig. 4. The following table gives comparative measurements, the rate of diffusion being taken as the maximum slope of the pressure-time curve, referred to hydrogen as 1000 units.

TABLE 2.—*Rate of Diffusion of Gases Through Copper at 700° C.*

Gas	Diffusion Rate
H_2	1000
H_2O	65
CO	17
CO_2	0 6

It will be seen that hydrogen will diffuse into copper approximately 15 times as fast as water, formed by the reaction of hydrogen on Cu_2O, can diffuse out; and similarly, that carbon monoxide diffuses through copper about 25 times faster than the carbon dioxide formed when it reduces the cuprous oxide.

This result seems to confirm the above explanation, that the weakness experienced by copper containing disseminated oxide, after exposure to reducing gases at high temperatures, is due to the internal fractures pro-

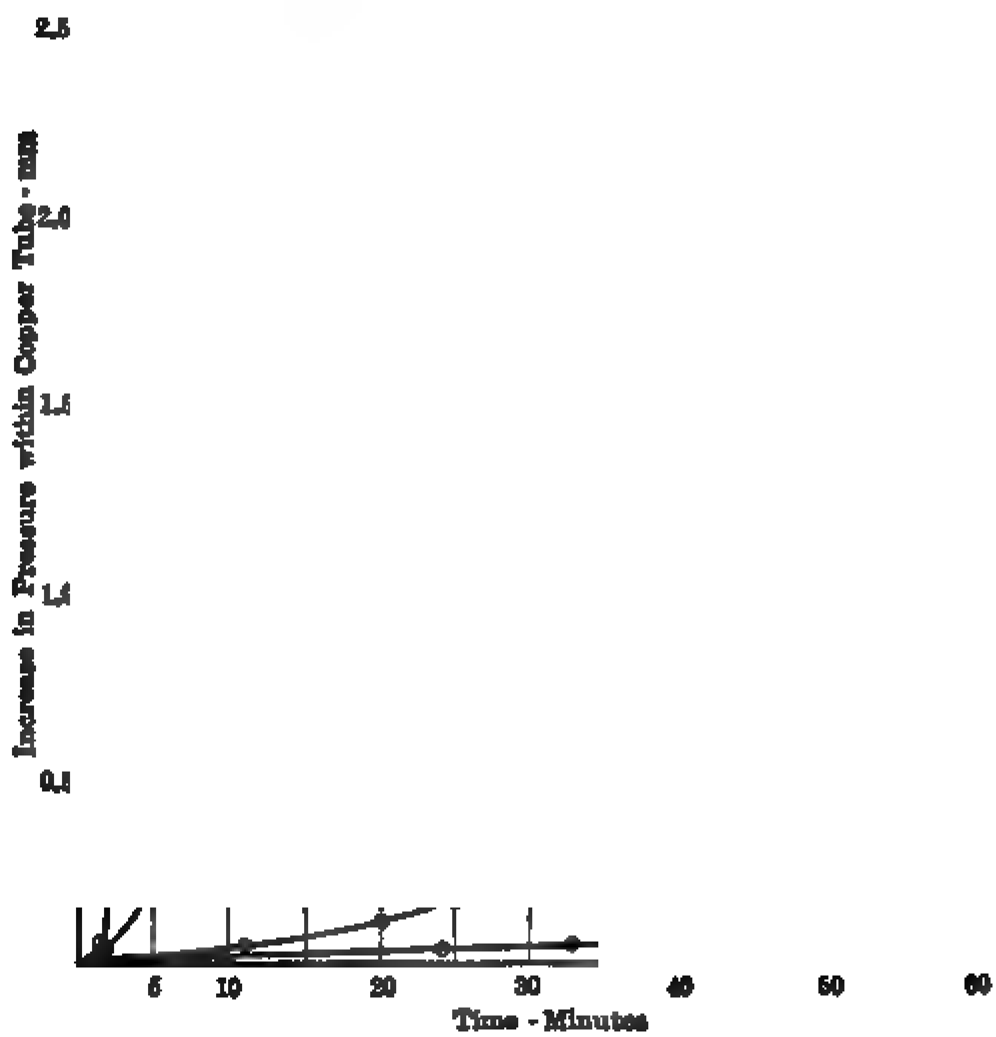


FIG. 4.—DIFFUSION OF HYDROGEN, STEAM, CARBON MONOXIDE, AND CARBON DIOXIDE THROUGH COPPER AT 700° C.

duced by the expansive action of a gas which is formed by the reduction of each oxide granule at a rate much faster than that at which it can dissolve in the copper and diffuse away.

An interesting check on the regularity of the measurements is that if the logarithm of the rate of diffusion, as found above, is plotted against the molecular weight of the gas, a straight line is obtained.

The transmission of hydrogen through copper was further studied by making diffusion measurements at a number of temperatures. The arrangement of the apparatus was the same as that described above, except that at temperatures above 700°, when diffusion was rapid

and the pressure change considerable, a direct-reading mercury manometer was used. The results, shown graphically in Fig. 5 and 6, are as follows, the rate at 700° being considered unity.

TABLE 3.—*Diffusion of Hydrogen Through Copper*

Temperature	Rate of Diffusion
950° C	17.0
850	10 0
750	2.6
700	1.0
500	0.54
400	0.006

Plotting the rate of diffusion against temperature, the curve (Fig. 7) first shows appreciable diffusion between 400° and 500°, and rises

10 20 30 40 50 60

Time - Minutes

FIG. 5.—DIFFUSION OF HYDROGEN THROUGH COPPER.

sharply beyond 700°. This agrees with the observations made on the physical effects of hydrogenation, recorded above, in which incipient deterioration in quality was noted in this same temperature interval. The diffusion rate measured at 800° and above is probably in excess of the

true rate of diffusion, due to the known fact that at these temperatures the fissures produced by the reaction on the oxide are of sufficient size to make the tube permanently porous.

Reduction of Cuprous Oxide by Hydrogen

To check the dependence of hydrogenation upon the diffusion rate of hydrogen through copper, a series of solid copper strips were exposed to hydrogen at temperatures between 200° and 900° for varying lengths of

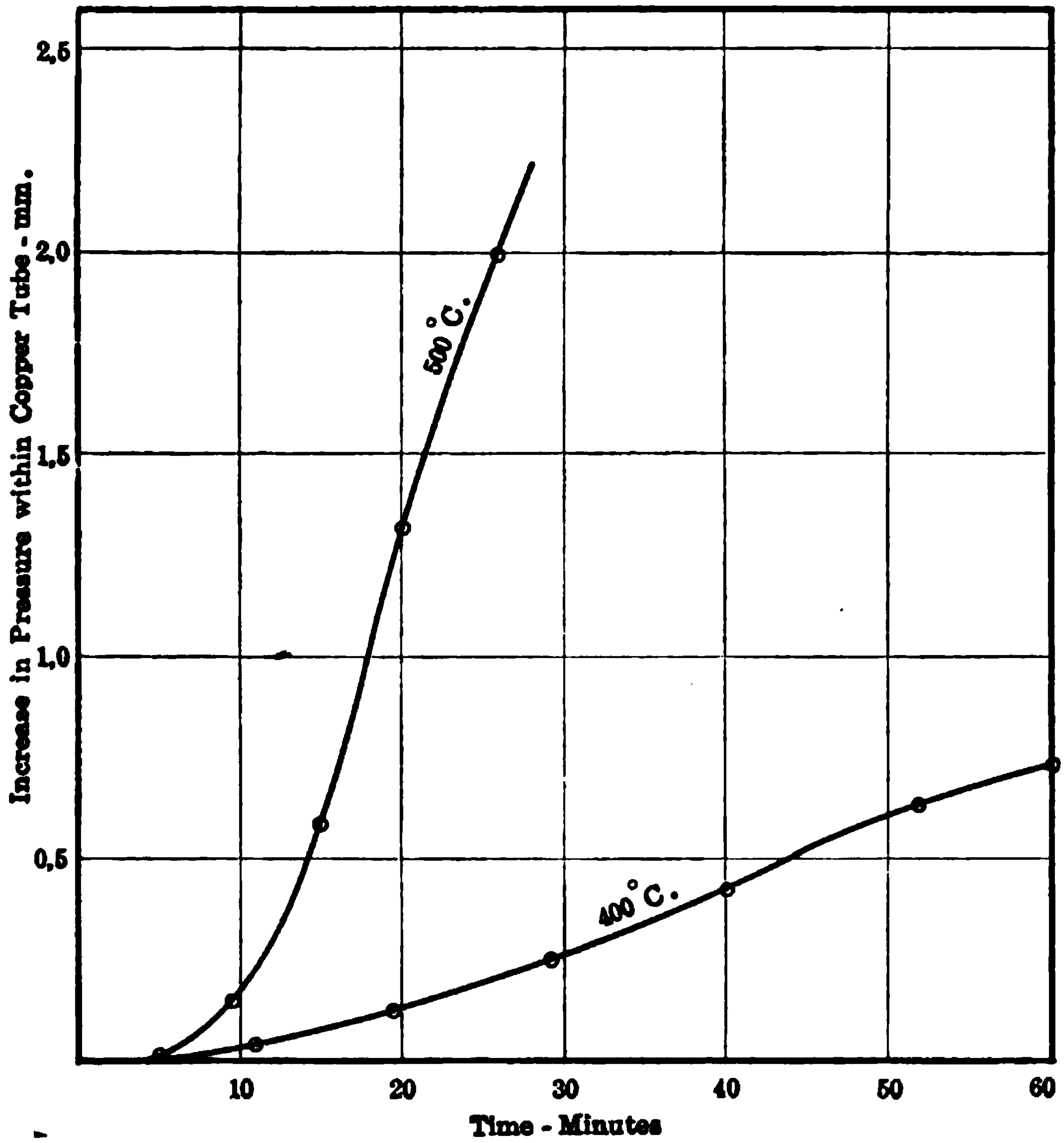


Fig. 6.—Diffusion of hydrogen through copper.

time. Since cuprous oxide is readily reduced to metal by hydrogen at 147° C.,[9] it is evident that the depth to which the reduction of the oxide granules has taken place is a measure of the depth to which the hydrogen has diffused, assuming that the hydrogen concentration necessary before reduction takes place is small. Cross-sections of these copper pieces were made and the depth of deoxidation was measured. It was found that the deoxidized envelope surrounding the central oxide-containing core, while not sharply defined, was of rather uniform thickness in indi-

[9] C. N. Otin: *Metallurgie* (1912), 9, 98.

vidual samples. A representative example of this penetration is shown in the micrograph, Fig. 14. The curves in Fig. 8 show how the depth of this layer varies with the time of exposure. There was no observable

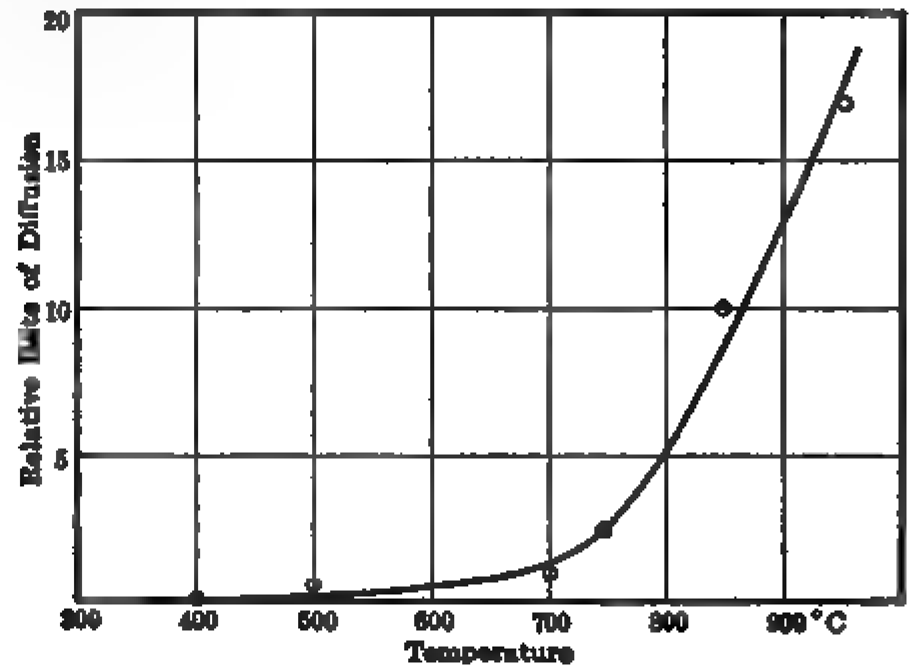


FIG. 7.—RATE OF DIFFUSION OF HYDROGEN THROUGH COPPER.

reduction of internal oxide particles at 400° after an hour's exposure, nor at any temperature below this. Taking the values of the initial slopes of this family of curves as proportional to the rate of diffusion,

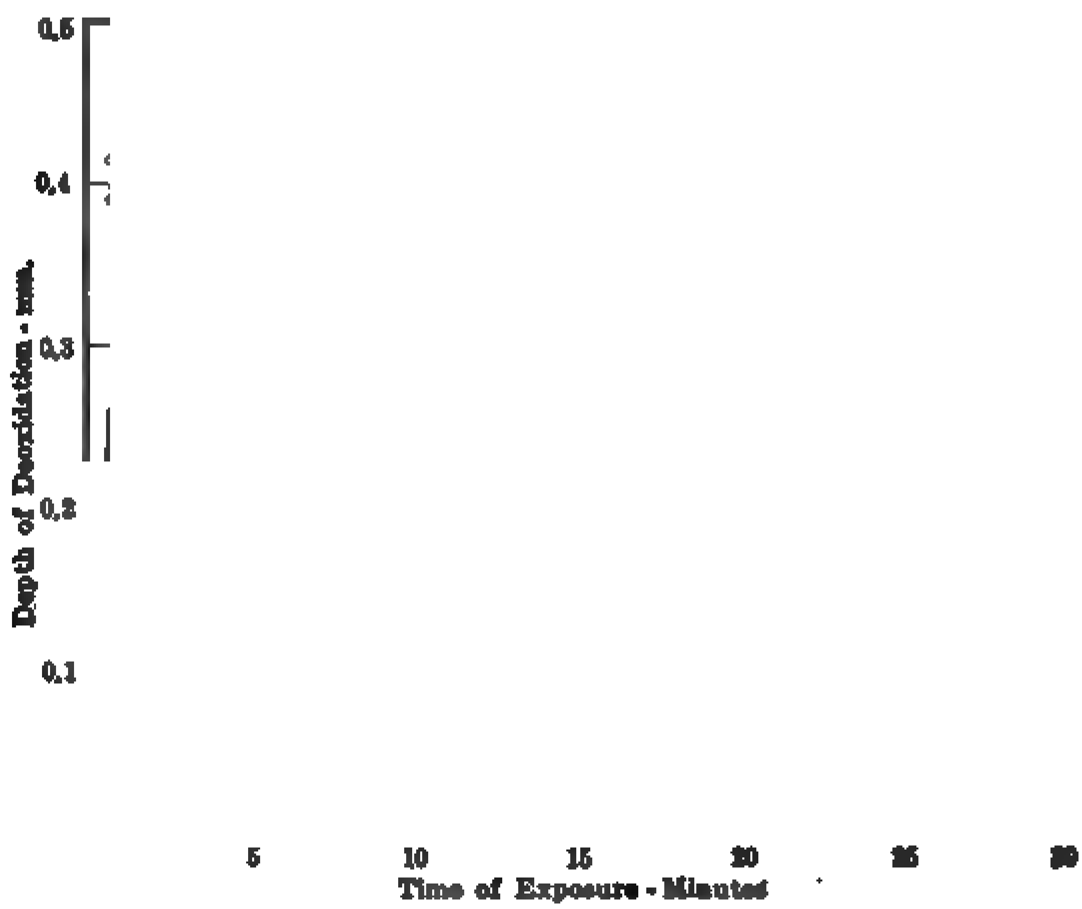


FIG. 8.—PENETRATION OF HYDROGEN INTO COPPER.

and plotting these values against the temperature, a curve is obtained (Fig. 9) very similar to the diffusion curve as measured by the copper tubes, but not influenced by the opening of minute crevices as the reduc-

tion of oxide proceeds. Active diffusion becomes apparent between 400° and 500° C.

A comparison between the two determinations is given in Fig. 10,

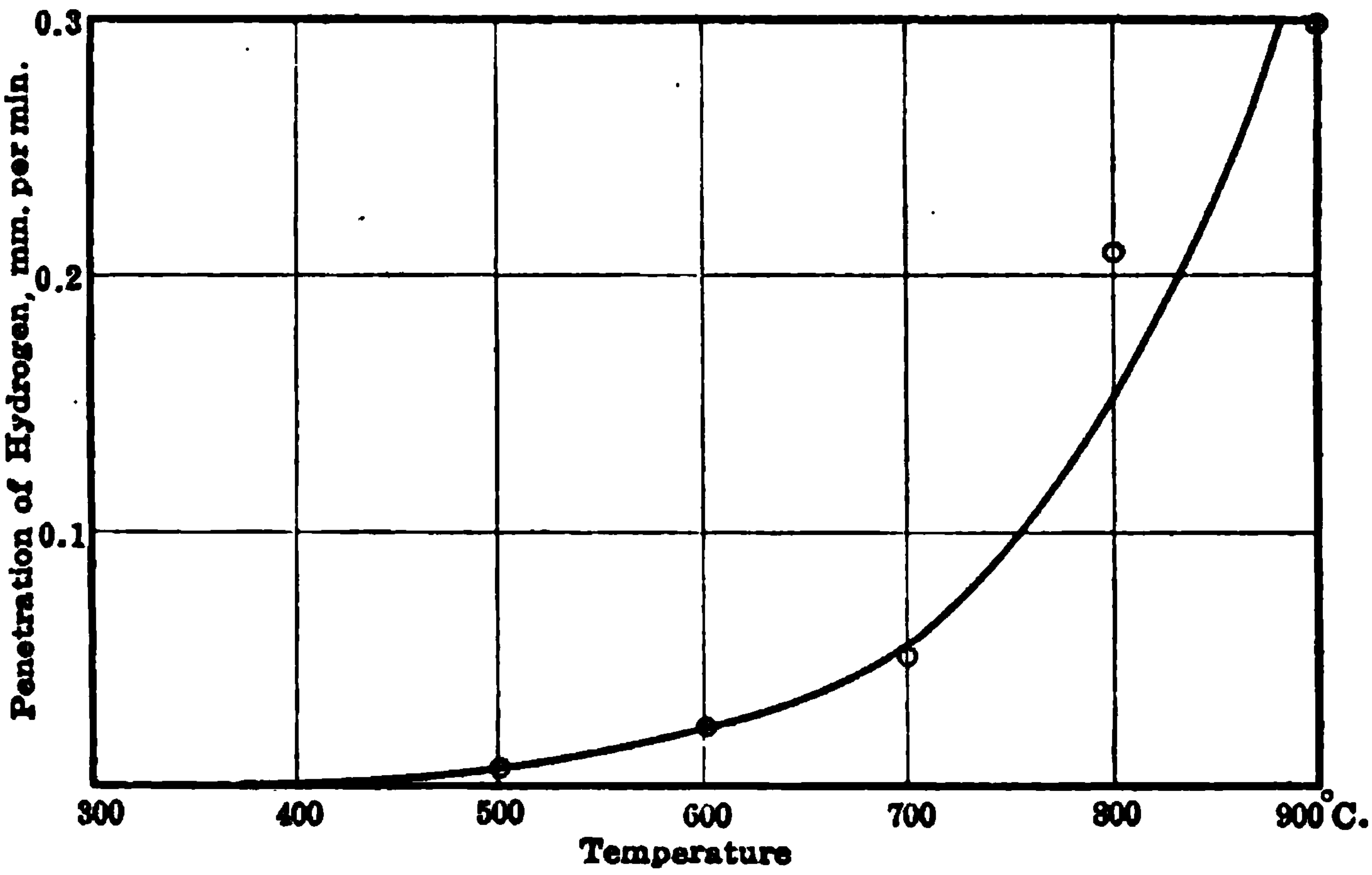


Fig. 9.—Rate of diffusion of hydrogen into copper.
(Using reduction of cuprous oxide particles as indicator.)

where the two diffusion curves are plotted to the same scale, *i.e.*, relative rates of diffusion compared with the rate at 700° as unity. The divergence above 700°, due to the influence of the increasing porosity of the copper tubes, is apparent.

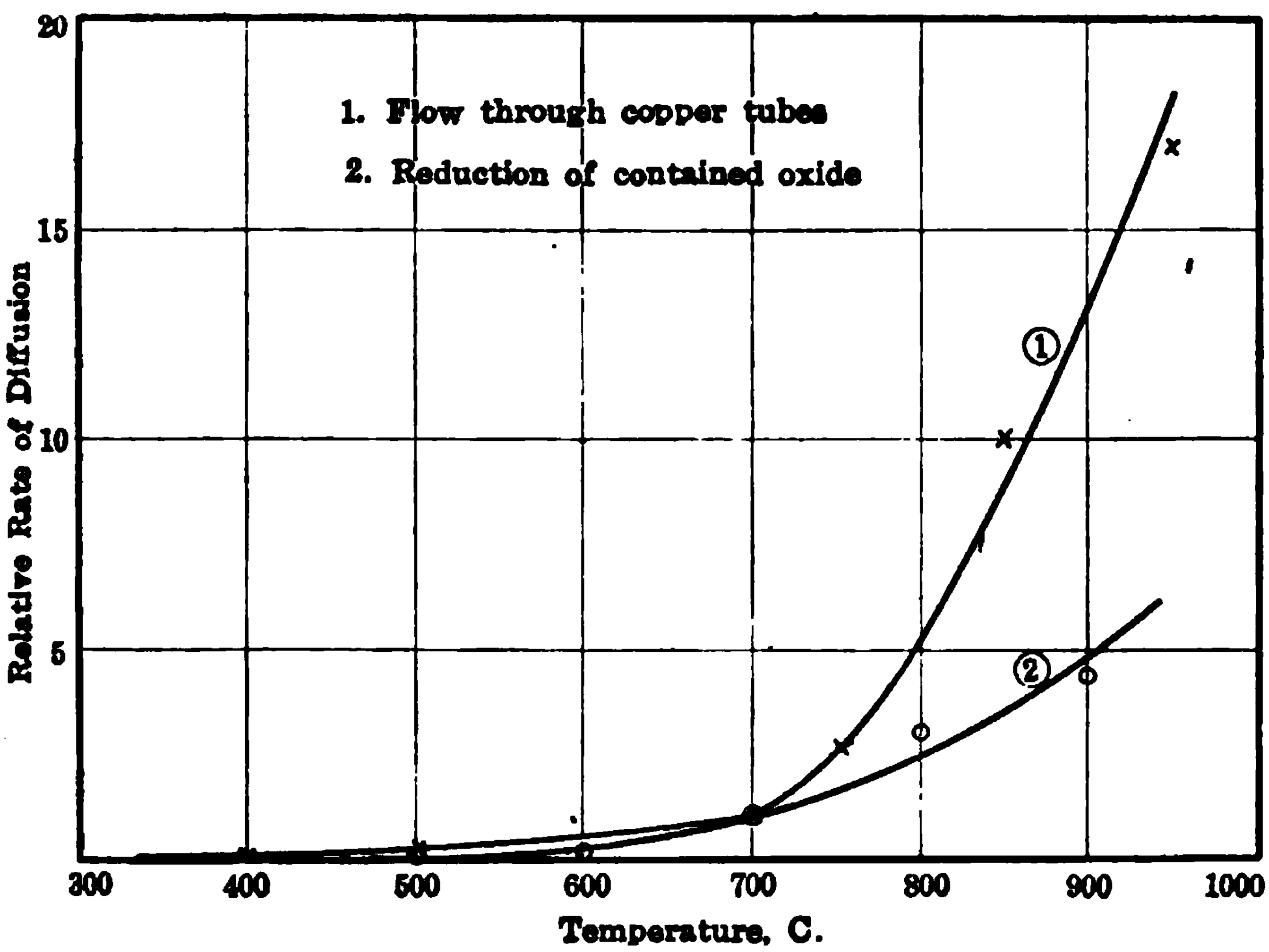


Fig. 10.—Relative rates of diffusion of hydrogen through copper.

Influence of Oxygen Content

The oxygen content of the copper strips used in all the foregoing work was 0.05 per cent. Copper strips containing larger quantities of

oxygen were obtained, and were given similar exposures to hydrogen, *i.e.*, 30 min. at 800°. A quantitative measure for the disruption of the copper is not easy to find, but an examination of the micrographs, Fig. 15 to 18, shows that as the oxygen content increases, the severity of the action also increases. The photographs are from unetched surfaces and the grain outlines are due wholly to the intercrystalline ruptures. A consideration of what happens during hydrogenation shows that it is not oxygen content alone that determines the severity of the action. The reaction that takes place when a particle of cuprous oxide is reduced to metallic copper is quantitative; the volume of the resulting void is definite, depending on the specific volumes of copper and cuprous oxide, and the quantity of water formed, existing as a gas and filling this space, is also definite. At a given temperature the ratio of these two quantities determines the pressure, but this ratio is independent of the total quantity of oxide present. The actual pressure, then, is a function of the temperature.

At high temperatures the cohesion between two copper grains is much less than the point to point cohesion within one of them, so that it is only the gas-filled pockets that happen to lie along a grain boundary that are operative in causing rupture. Since this is so, cast copper, in which all the oxygen present is concentrated along the grain boundaries as a cuprous oxide-copper eutectic, is peculiarly susceptible to hydrogenation. This is strikingly shown in Fig. 19 and 20, which is a cast copper containing but 0.02 per cent. oxygen, and Fig. 21, showing a piece of cast copper containing 0.50 per cent. oxygen (more than the eutectic concentration) before and after hydrogenation. In the latter case, the explosive action of the gas formed has completely shattered the metal.

In wrought copper, during the process of rolling, the oxide particles become thoroughly mixed with the metal, the recrystallization taking place with complete disregard of their presence, so that the situation of an oxide granule at a grain boundary is governed simply by chance. An increased oxygen content increases the severity of hydrogenation in wrought copper only because of the greater possibility of oxide granules to lie along the grain boundaries.

From the nature of the action which causes the mechanical deterioration, it is not expected that any chemical or heat treatment short of remelting would restore hydrogenated copper to its former condition.

FIG. 11.—ROLLED COPPER, O = 0.05 PER CENT. UNTREATED, × 100.

FIG. 12.—SAME AS FIG. 11, HEATED 30 MIN. AT 800° C. IN HYDROGEN. × 100.

FIG. 13.—SAME AS FIG. 11, HEATED 30 MIN. AT 1050° C. IN HYDROGEN. × 100.

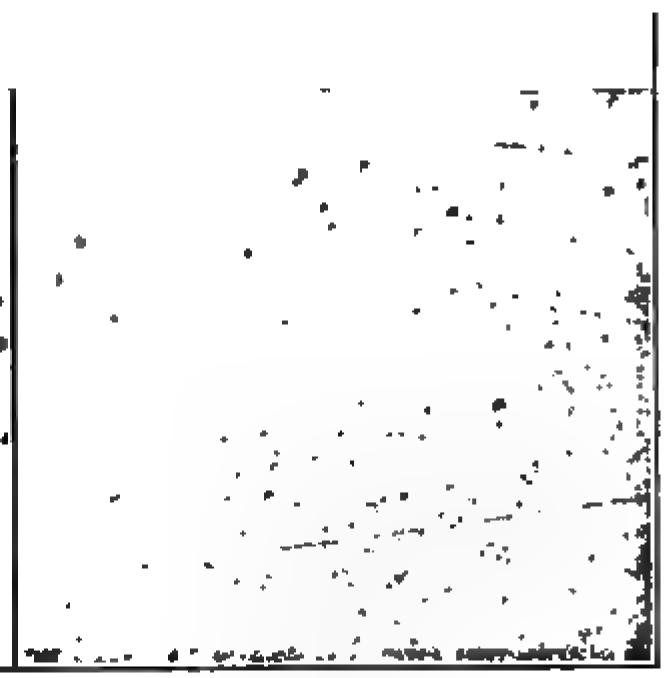


FIG. 14.—PENETRATION OF HYDROGEN INTO COPPER. EXPOSED TO HYDROGEN 2 MIN. AT 800° C. × 100.

FIG. 15.—ROLLED COPPER, O = 0.09 PER CENT. UNTREATED × 100.

FIG. 16.—SAME, HEATED 30 MIN. AT 800° C. IN HYDROGEN. × 100.

Fig. 17.—Rolled copper, 0 = 0.21 per cent. Untreated. × 100.

Fig. 18.—Same, heated 30 min. at 800° C. in hydrogen. × 100.

Fig. 19.—Cast copper, 0 = 0.02 per cent. Untreated. × 100.

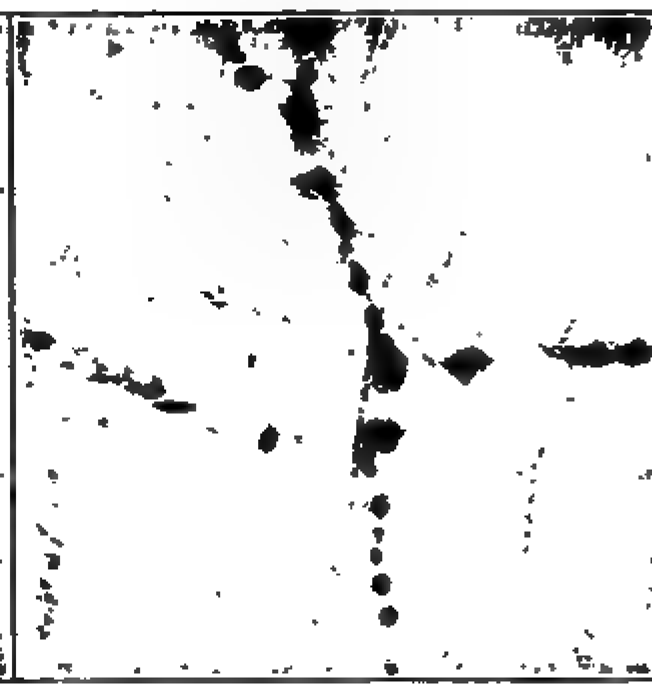


Fig 20.—Same, heated 30 min. at 800° C. in hydrogen. × 100.

Fig. 21.—Cast copper, 0 = 0.50 per cent., before and after heating in hydrogen at 850° C. Natural size.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the Milwaukee meeting, October, 1918, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Nov. 1, 1918. Any discussion offered thereafter should preferably be in the form of a new paper.

The Spectroscopic Determination of Lead in Copper

BY C. W. HILL,* PH. D., AND G. P. LUCKEY, M. A., PITTSBURGH, PA.

(Milwaukee Meeting, October, 1918)

In a previous article[1] preliminary experiments were described, indicating the possibilities of a quantitative spectroscopic method for the determination of small amounts of lead in copper, which would be accurate and rapid, and could be carried out in the refining plant by one not skilled in chemical analysis. The present paper deals with the development of the method in the factory, giving the details of apparatus and its standardization, and presenting a comparison of the accuracy of the method with that of the standard electrolytic determination. (For variations and other applications of the method, the reader is referred to the first article.)

Start—Lead line bright.

——— Lead becoming faint.

End — Lead line gone.

Fig. 1.—Steps in the elimination of lead.
(The lead line, at point 405.8 in the violet portion of the spectrum, is seen between the two copper lines, 402.29 and 406.29, lying close to the latter. The crowded faint lines are due to the carbon arc.)

1. Outline of Method

A carefully weighed sample (0.4 gm.) of the copper to be tested is placed in a cavity in a graphite positive electrode. An arc capable of

---

* Research Chemist, Westinghouse Electric and Mfg. Co.

[1] *Proceedings* Am. Electrochem. Soc. (1918), 32, 191. *Met. and Chem. Eng.* (1917), 17, 659.

regulation is struck, and maintained under constant conditions between the copper sample and a rotating upper carbon electrode. A spectroscope is so adjusted as to observe the lead line (405.8 $\mu\mu$), as shown in Fig. 1.

With a stop-watch, the time is determined between the melting of the copper sample and the disappearance of the lead line from the spectrum. This time is proportional to the lead content of the sample, the exact values depending upon the apparatus employed. The apparatus

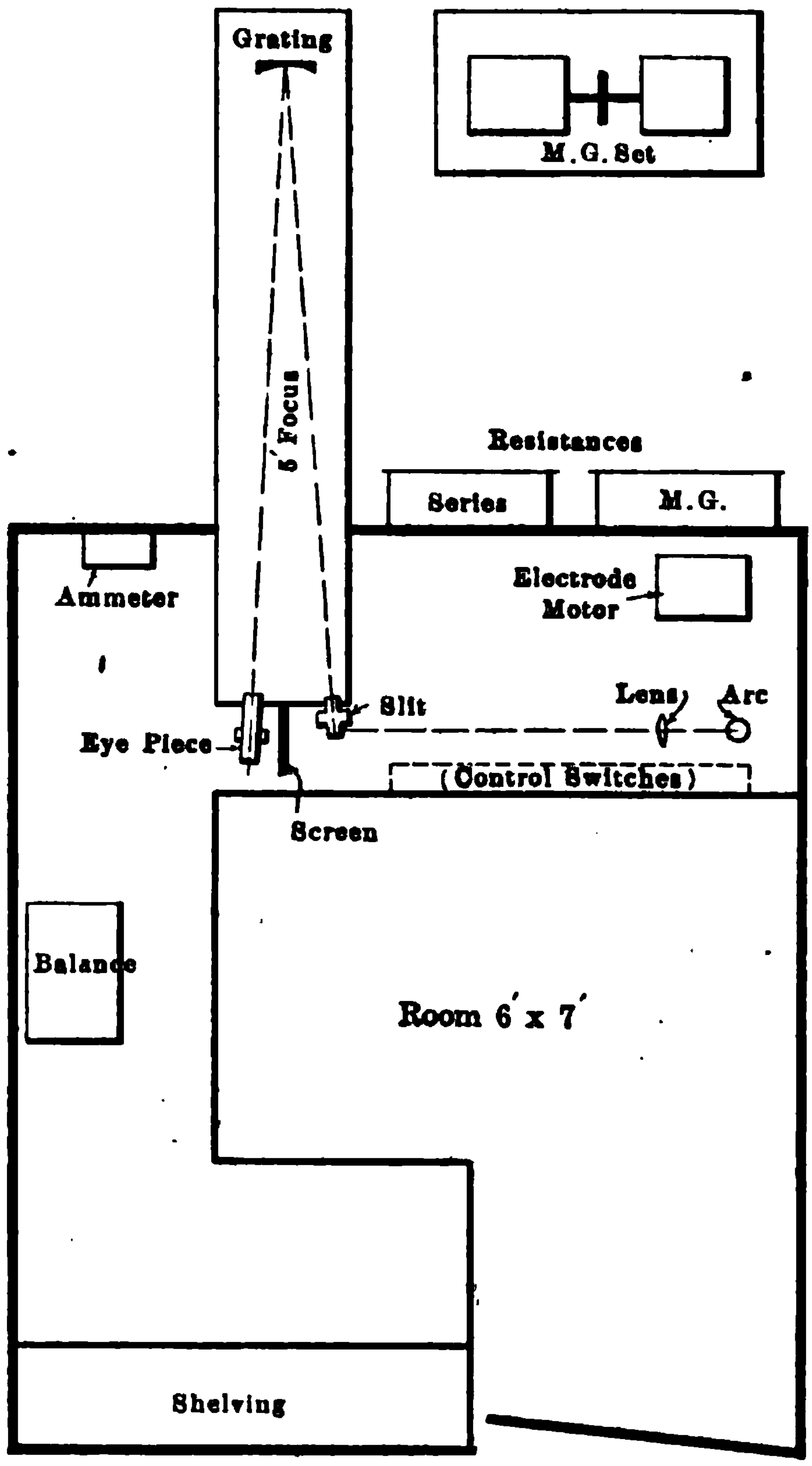


FIG. 2.—PLAN OF TESTING ROOM.

is calibrated with samples of known lead content and a time-lead curve is established for the apparatus. Where minimum values alone are required, the time of disappearance of lead from a sample of satisfactory copper is taken as a standard, and the refining process is continued until furnace samples show a time equal to or less than the standard.

2. APPARATUS

The apparatus and its arrangement as finally installed are shown diagrammatically in Fig. 2 and in the photograph Fig. 3. A full description

of the various parts of the apparatus will be found in Appendix I. On account of conditions due to the war, we were unable to purchase a spectroscope suitable for the work, and were forced to use a grating, which required more space.

FIG. 3.—ARRANGEMENT OF TESTING APPARATUS.

A—Graphite positive electrode.
B—Neg. electrode and contact.
C—Electrode pulley.
D—Arc-length control.
E—Lens.
F—Prism and slit.
G—End of 5-ft. box.
H—Eye-piece.
I—Screen.
J—Motor-generator switch
K—Motor-generator rheostat.
L—Arc switch.
M—Series resistance knob.
N—Rotating electric switch.
O—Rotating electric motor.
P—Joly balance.
Q—Ammeter.
R—Colored-glass screen.

3. STANDARDIZATION OF APPARATUS

Our first two attempts to standardize the apparatus were not successful. However, we shall give some of the details regarding them, since they throw some light on the relative accuracies of the spectroscopic and electrolytic methods for small quantities of lead. The three methods

of calibration were: (1) checking routine analyses; (2) comparative analyses of large samples; (3) comparative analyses of synthetic samples.

Checking Routine Analysis

For a period of several weeks, the spectroscope was used in comparison with regular routine analyses by the electrolytic method. (Description of method will be found in Appendix II). The results seemed to check the work of some of the chemists quite accurately, but at best the uncertainty was too great to establish a calibration.

Analysis of Large Samples

Five large samples of copper shot were made by selection from regular furnace runs on the basis of the routine test. These were submitted to three chemists for chemical determination of lead, and were examined in the spectroscope. We were still unable to check the chemical method, and consequently returned the samples for repeat analysis, including repeat samples on regular routine tests. The values obtained are given in Table 1. The analyses on the special samples were made by three chemists, two of them using a 10-gm. sample and one a 25-gm. sample, working independently.

TABLE 1.—*Lead Contents of Special Samples*

No.	Original Anal. by 3 Chemists			Av.	Check by 3 Chemists			Av.	Check by 2 Chemists		Av.
1	0.005	0.006	0.005	0.005	.....	.....	.....	.....	0.005	0.005	0.005
2	0.005	0.005	0.007	0.007	0.012	0.012	0.012	0.012			
3	0.010	0.010	0.010	0.010	0.012	0.012	0.015	0.013			
4	0.015	0.015	0.015	0.015	0.013	0.013	0.013	0.013	0.014	0.017	0.015
5	0.020	0.020	0.020	0.020	.....	.....	.....	.....	0.022	0.022	0.022

Lead Contents of Furnace Samples

Original Analysis	Check Analysis
0.012	0.005
0.017	0.008
0.018	0.017
0.022	0.020
0.027	0.038

As might be expected, the routine analyses, which are often rushed, do not show the accuracy of the special analyses. From the results given, and from an extended investigation of the electrolytic method in our analytical laboratory by others, it appears that the possible error in the

electrolytic method is of the order of 0.003 per cent. for careful work, and 0.005 per cent. for rapid routine tests.

The readings, in seconds, by the spectroscopic method for the special samples are given in Table 2. These are averages of ten readings by two observers, *A* and *B*. For comparison, the percentage of lead is cal-

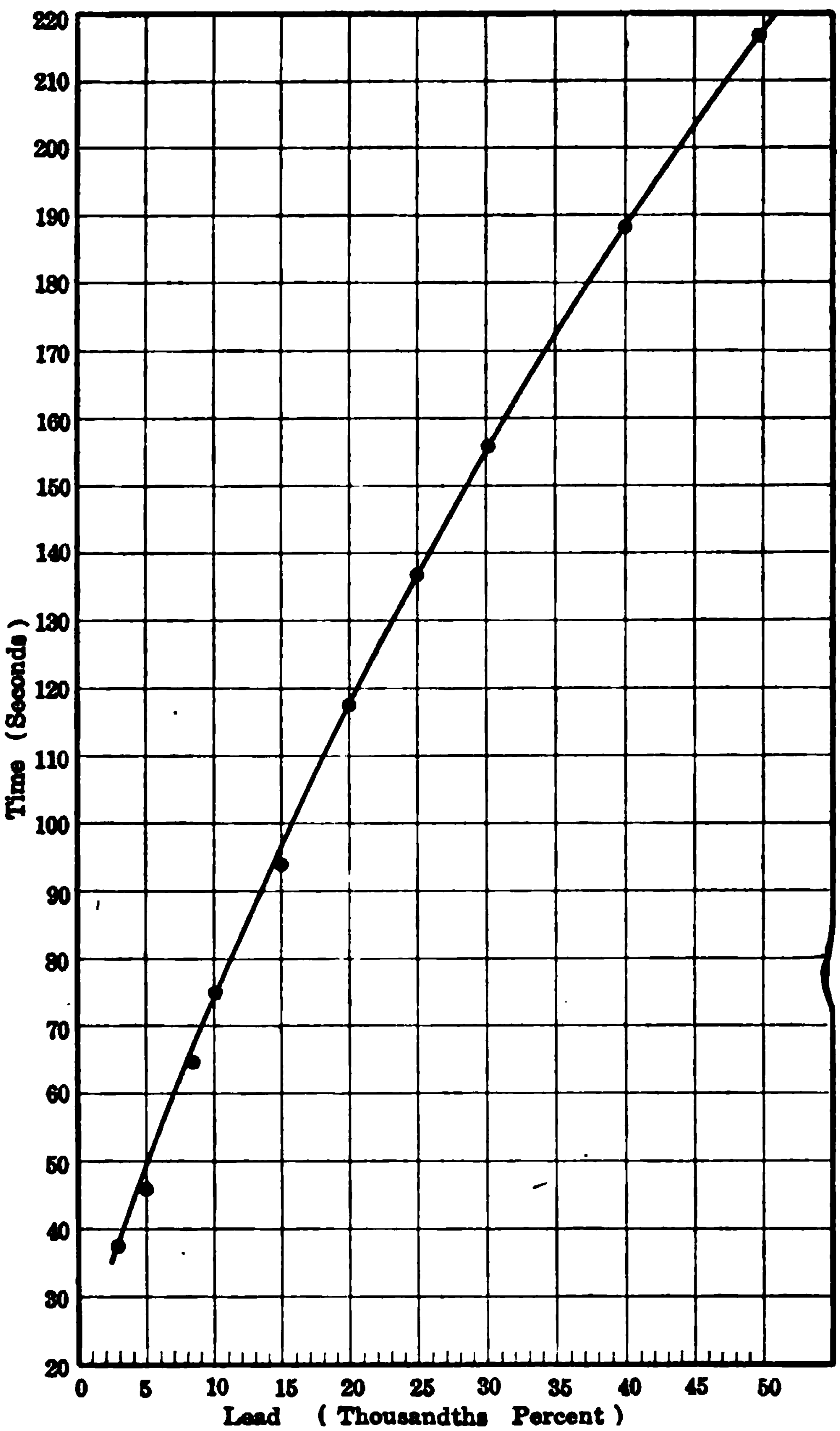


FIG. 4.—CALIBRATION CURVE, ON SYNTHETIC SAMPLES.
(10 amperes, 220 volts. Arc, 1 cm. long. Upper carbon, ½ in. Lower graphite, 1⅛ in.)

culated from the time and the time-lead curve, after this had been established with synthetic samples. The errors expressed are the average deviation from the mean, and would probably represent the order of the possible error.

TABLE 2.—*Comparison of Spectroscopic and Analytic Methods*

No.	Spectroscopic Method				Per Cent. Lead by Analysis	Difference
	Time in Seconds, 2 Observers			Per Cent. Lead from Curve		
	A	*B*	Av.			
1	65 ± 4	76 ± 7	70 ± 5	0.009 ± 2	0.005 ± 4	0.004
2	107 ± 3	98 ± 5	103 ± 4	0.017 ± 2	0.009 ± 4	0.008
3	94 ± 9	104 ± 7	99 ± 8	0.016 ± 2	0.012 ± 3	0.004
4	88 ± 4	90 ± 8	89 ± 4	0.014 ± 2	0.014 ± 2	0.000
5	122 ± 2	125 ± 8	124 ± 4	0.021 ± 2	0.021 ± 3	0.000

It is to be noted that we have been dealing with the accidental errors of the two methods, and that we have not attempted to express the probable error. The figures indicated the existence of systematic errors, since the determinations by the two methods differ by more than the possible error of each. These differences are the greatest with samples of small lead content, the electrolytic method being uniformly lower than the spectroscopic. It is known that the electrolytic precipitation of the oxidized lead is not complete under certain conditions, and the systematic error would tend to give low results. If we select the highest individual chemical analysis we have a much better agreement between the two methods. Since the spectroscopic method is standardized under the conditions of operation, any systematic errors in the method will be included in the standardization, and we are therefore concerned only with the accidental errors.

Synthetic Samples

Synthetic samples were made in the laboratory by adding a carefully weighed amount of pure lead to the required amount of molten pure copper (Cu 99.963 per cent.) in new fire-clay crucibles under charcoal cover, mixing thoroughly and pouring into fine shot.

The spectroscopic readings were made by the furnace foreman who will use the method in control of the refining furnace. It should be noted that this observer is not experienced in the use of the spectroscope and his training has been in factory production rather than in investigative work. The readings were taken at random, so the observer could have no indication of the lead content of the sample under test. The individual readings are given in Table 3, and from these the averages and errors are calculated. The time-lead curve arising from these readings is shown in Fig. 4. (In regular factory operation the known samples will be run at regular intervals so that any incorrect adjustments will be detected.) This is clearly the best method for standardizing the apparatus.

TABLE 3.—*Time (Seconds) on Synthetic Samples*

Per Cent. Lead	0.000	0.003	0.005	0.008	0.010	0.015	0.022	0.025	0.030	0.040	0.050
Time, sec	0	27	45	56	60	87	122	142	179	203	229
	0	50	30	59	70	111	125	149	171	193	205
	0	50	53	55	94	90	104	139	170	201	207
	0	43	44	51	66	80	115	130	161	160	205
	0	30	45	75	93	86	111	156	138	180	236
	..	38	37	71	78	98	116	132	138	208	
	..	34	44	66	79	102	117	123	158	168	
	..	26	68	67	70	134	112	...	127	191	
	..	..	..	71	..	120	...	...	...	212	
Average	..	38	46	65	76	94	117	138	156	188	216
Av. deviation	..	9	7	7	8	9	5	9	18	14	13
Prob. error	..	3	4	2	3	3	2	3	9	14	6

High-lead Samples.—For the sake of completeness, a few tests were run on samples with lead content much above that usually determined in copper refining; results are given in Table 4. On account of the smaller number of observations, the probable error is greater than in the samples of small lead content.

TABLE 4.—*Readings on High-lead Samples*

Per Cent. Lead	0.100	0.150	0.200	0.300
Time, sec	240	260	290	408
	228	250	352	456
	245	226	292	450
	222	269	345	448
	248	330	319	437
Average	236	267	320	440
Av. deviation	8	29	22	14
Prob. error	4	12	10	6

Doubt may naturally arise as to possible loss of lead in making the synthetic samples. John Johnson[2] gives the vapor pressure of lead at 1176° C., according to Greenwood's experiments, as 0.022 atmosphere, or 16.7 mm. Hg. Using the equation by Johnson for calculating the vapor pressure, we obtain 15.2 mm. for the same temperature. It is certain that our samples were not heated so high as this and as they were made rapidly it is obvious that the loss of lead must have been slight. The vapor pressure of lead dissolved in molten copper would be less than that of lead alone, at the same temperatures. The close agreement of the analyses by the two methods on special samples No. 4

[2] *Jour. Ind. & Eng. Chem.* (1917), 9, 873.

and 5 would indicate no loss of lead in preparing the samples for standardization.

4. Variations in Conditions

The variables which might affect the accuracy of the method are:

1. Size of sample.
2. Uniformity of sample.
3. Current variations.
4. Variations in optical apparatus.
5. Arc length.
6. Drafts around electrode.
7. Speed of rotation of electrode.
8. Personal factor.

1–2. *Size and Uniformity of Sample.*—It is obvious that the size of the sample is so small that the method cannot be used with material which is not homogeneous. Enlarging the sample to 1 gm. would hardly make the method applicable to this kind of material. If the furnace sample is properly taken, and is stirred before pouring into shot, we find no evidence of segregation of lead with the low-lead samples which we have been using.

Error is possible in weighing out the sample. Where analytic balances of the usual type are used it is an easy matter to weigh rapidly to 0.001 gm. From the experiments with samples of different weights discussed in our previous paper, it is seen that the time of disappearance of a given unit of lead is not proportional to the weight of the sample. These experiments indicate that an error in weighing of 0.01 gm. would be necessary before the resulting determination of lead would be changed 0.001 per cent.

However, to be certain in this matter, samples having different weights were run, using one sample of low-lead content (0.005 per cent.), and one in which it is quite high (0.050 per cent.). Results are given in Table 5.

Table 5.—*Variation due to Weight of Sample*

Weight, Gm.	0.005 Per Cent. Pb., Sec.	0.050 Per Cent. Pb., Sec.
0.397	42	205
0.398	51	
0.399	48	200
0.400	46	210
0.400	54	230
0.401	43	220
0.402	43	211
0.403	40	220
	—	—
Average	46	214
Standard (0.400)	46	216

It is obvious that the small errors in weighing do not affect the lead determination. A systematic error in weighing would affect the standard samples with which the apparatus is checked from time to time, and would soon be detected.

Using the Joly balance, the 0.4-gm. point of which was 45.0 on the scale, the following times were obtained with a sample containing 0.010 per cent. lead, the standard time of which was 75 sec.

Reading, Joly Balance	Time in Seconds
44.5	85 79 95
45.0	93 75
45.5	67 76 50 60
	Average, 75 sec.

The Joly balance can be read within 0.05; hence the error in weighing with the balance will not influence the results.

3. *Current Variations.*—The arc is somewhat unstable, but if sufficient series resistance is included on a high-voltage line, the variations in the arc, when set, are not sufficient to affect the determination. The current should be large enough to melt the sample readily and to keep the globule of copper at a uniform temperature. With low amperages, part of the bead is cold and erratic results are obtained. High amperage increases sputtering but gives better light. While our apparatus is standardized for 10 amp. at 220 volts, good results were obtained with 11 amp. With our apparatus the amperage fluctuates regularly from 9.75 to 10.25, and gives a good average of 10 amp., as shown in Table 6.

TABLE 6.—*Variation due to Fluctuating Current*

Current, Amp.	0.005 Per Cent. Lead, Sec.	0.010 Per Cent. Lead, Sec.
8	48 54	80 87
9	43	75
10 (Normal)	42 46	75 76
11	41 40	66 64
12	40 38	58 58
Standard	46	75

It would appear that the current variation gives rise to an error of the first magnitude. However, with proper arrangement, the variation can be reduced to a range that will give accurate results.

4. *Variation in Optical Apparatus.*—There can be no disarrangement of the optical apparatus which can affect its accuracy unless the operator attempts to observe the disappearance of small amounts of lead with an apparatus so poorly adjusted that the end is not distinct. One becomes accustomed to the proper setting and immediately notices any change in adjustment.

5. *Arc Length.*—While it is an easy matter to maintain a constant arc length, it is to be remembered that this will not affect the current.

6. *Drafts.*—The arc should not be subjected to drafts of air, since these make the arc unsteady and cool the bead. While we have never attempted to shield the arc, it is quite possible that a properly devised shield would promote even greater accuracy.

7. *Speed of Electrode.*—The speed of rotation of the electrode should be such as to center the arc and keep it from wandering. Too great a speed tends to drafts and sputtering of the arc. In our apparatus the rate is 1000 revolutions per minute.

8. *Personal Factor.*—There appears to be a personal factor in using the method, but it is usually small and constant. One observer may read a certain number of seconds longer than another on the same sample; this is probably due to difference in the sensitivity of the eye. With experienced observers, and even with those who are new to the work, it has been possible for two observers to check each other months apart. Where there is more than one operator it would be safest for each to establish his own calibration curve, using the same standard samples.

5. Advantages and Limitations

It is obvious that the method can be used only on copper in which the lead is uniformly distributed throughout the samples. If care is taken in preparing the shot from the ladle, we have found no evidence of segregation. The occasional readings which vary widely from the average are, in all probability, due to arc wandering or unsteadiness, affecting the temperature of the molten copper. It is our experience that these exceptional readings are almost always high, and we have usually been able to associate such readings with irregularities in the arc. There is a tendency for small particles of the sample to be thrown out from the molten bead; this can be lessened by rotating the upper electrode more slowly and by cutting down the arc current. When reduced to a minimum it does not interfere with the test, but is accounted for in the calibration of the apparatus.

The advantages of the method are facility and accuracy. The analyses can be made in the refining plant by the foreman or by someone who has at least a High School education. The process of refining can be followed rapidly, without holding the furnace for a chemical analysis. Even the last analysis, just before pouring, which requires the greatest accuracy, can be made in a few minutes, and the accuracy of the method at this point is greater than that of the chemical method.

We are indebted to Messrs. Hineline and Nuzum for the spectroscopic tests on the special and synthetic samples, and to Messrs. Gwaltney and Demler for the chemical analyses.

Appendices

1. *List of Materials*

Arc Apparatus:

Motor-generator set.

Westinghouse 3-hp. ind. motor, 220-volt, 3-phase, style 170,906.

Westinghouse 3-hp. d.-c. generator, 230-volt, style 212,677.

Rheostat on motor-generator set, Westinghouse field rheostat, 30 ohms.

Rheostat in series with arc, Westinghouse field rheostat, 200 ohms. 250-volt style.

¼-hp. motor, or smaller, for rotating electrode.

3-pole, single-throw, switch for motor-generator set.

2-pole, single-throw, switch for arc and motor.

1 snap switch for motor on rotating electrode.

Ammeter, d.-c., 0 to 15 amp., switchboard type.

Arc adjusting outfit.

Graphite cups and upper carbon electrodes.

Remodeled drill press for rotating upper electrode.

Optical Apparatus:

Spectroscope or grating, with lens to focus arc image on slit.

Accessories:

Scale, or Joly balance.

Screen for observing arc (colored glass).

Stop-watch.

Standard weight.

2. *Method of Chemical Analysis for Lead in Copper*

A 10-gm. sample is dissolved in 45 c.c. nitric acid (s.g. 1.40). The solution is boiled until evolution of nitric oxide fumes ceases, and it is then neutralized with ammonia. The precipitate is dissolved in nitric acid and 5 c.c. conc. acid is added in excess. The solution is then diluted to 125 c.c. and electrolyzed 30 min. with a current of 1 amp. at 25 volts. The electrode is a platinum gauze cylinder 2 in. high, ⅞ in. diameter, with 10-mil wire, 50 to the inch, giving an anodic area of approximately 15 sq. in. or 100 sq. cm. The electrode is washed in alcohol and dried at 180° C.

3. *Test of Joly Balance*

Instead of the regular analytic balance, it has been proposed to use a Joly balance, which may be calibrated from time to time with a standard weight (0.4 gm.) equal to the copper sample to be used. For testing our Joly balance, the weights were 0.4000 ± 5 gm., and the readings (scale in centimeters) were:

44.75	44.80	
.62	.60	
.75	.75	
.70	.75	
.75	.78	
.80	.75	
.80	.75	
.80	.75	Average 44.75 ± 1

Repeated readings with the standard weight on the Joly balance gave the same values (44.75 ± 1). The Joly balance can be made equal if not superior in accuracy to the analytical balance over a given range, and is more rapid. Probably the accurate types of torsion balance, such as made by the Roller Smith Co., Bethlehem, Pa., and used for weighing lamp filaments, might be used in this work, but they are rather expensive.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

Notes on Electric-furnace Problems

BY J. L. MCK. YARDLEY,* PITTSBURGH, PA.

(New York Meeting, February, 1919)

THERE are two general classes of problems in connection with electric furnaces. First, those relating to the best utilization of the electrical power inside the furnace; second, those connected with the bringing of the electrical power to the point where it is to be utilized. Referring particularly to the latter class of problems, many calculations have been made, covering a wide variety of furnaces, to check the electrical capacity and power factor found from test. The following analysis, made for the purpose of determining the maximum capacity and approximate performance of a new furnace, to operate at 160 volts on a 60-cycle circuit, may be of interest.

The first characteristic necessary to determine is the inductance, since this is the factor that limits the amount of power which can be put into the furnace. Inductance is calculated from the dimensions of the furnace, according to formulas of the U. S. Bureau of Standards,[1] as

Formula 99, for mutual inductance, is:
follows.

$$M = 2l\left[\log\frac{2l}{d} - 1 + \frac{d}{l}\right]$$

Formula 103, for self-inductance, is:

$$L = 2l\left[\log\frac{2l}{R} - 1 + \frac{R}{l}\right]$$

Both of these formulas are approximations which are nearly correct when l is great compared to d or R.

l = length of circuit, in centimeters,

d = separation between the conductors, in centimeters,

R = geometric mean radius of conductors. For a circular tube, R = the radius of the circle. For a solid circular conductor, $R = 0.7788 \times$ the radius of the conductor. For a rectangular conductor, $R = 0.2235 \times (a + b)$, a being the length, and b being the width of the rectangle.

To calculate the inductance of a 3-phase circuit, it is customary to figure the inductance of one leg. In circuits where the three conductors

---

* General Engineer, Westinghouse Elec. & Mfg. Co.

[1] *Bull.* U. S. Bureau of Standards (1912), 8, No. 1.

are arranged in a plane with equal spacing, the equivalent separation of all three conductors from each other is equal to $\sqrt[3]{2}$ times the actual separation. The inductance of one leg of the 3-phase circuit is obtained by subtracting the mutual inductance M from the self-inductance L. This is because the action of the current returning in the other wires reduces the inductance of the wire that is being calculated.

The type of electric furnace under consideration is similar to that shown in Fig. 1. For purpose of calculation, the furnace circuit was divided into four parts: electrode, holder, flexible lead, and transformer

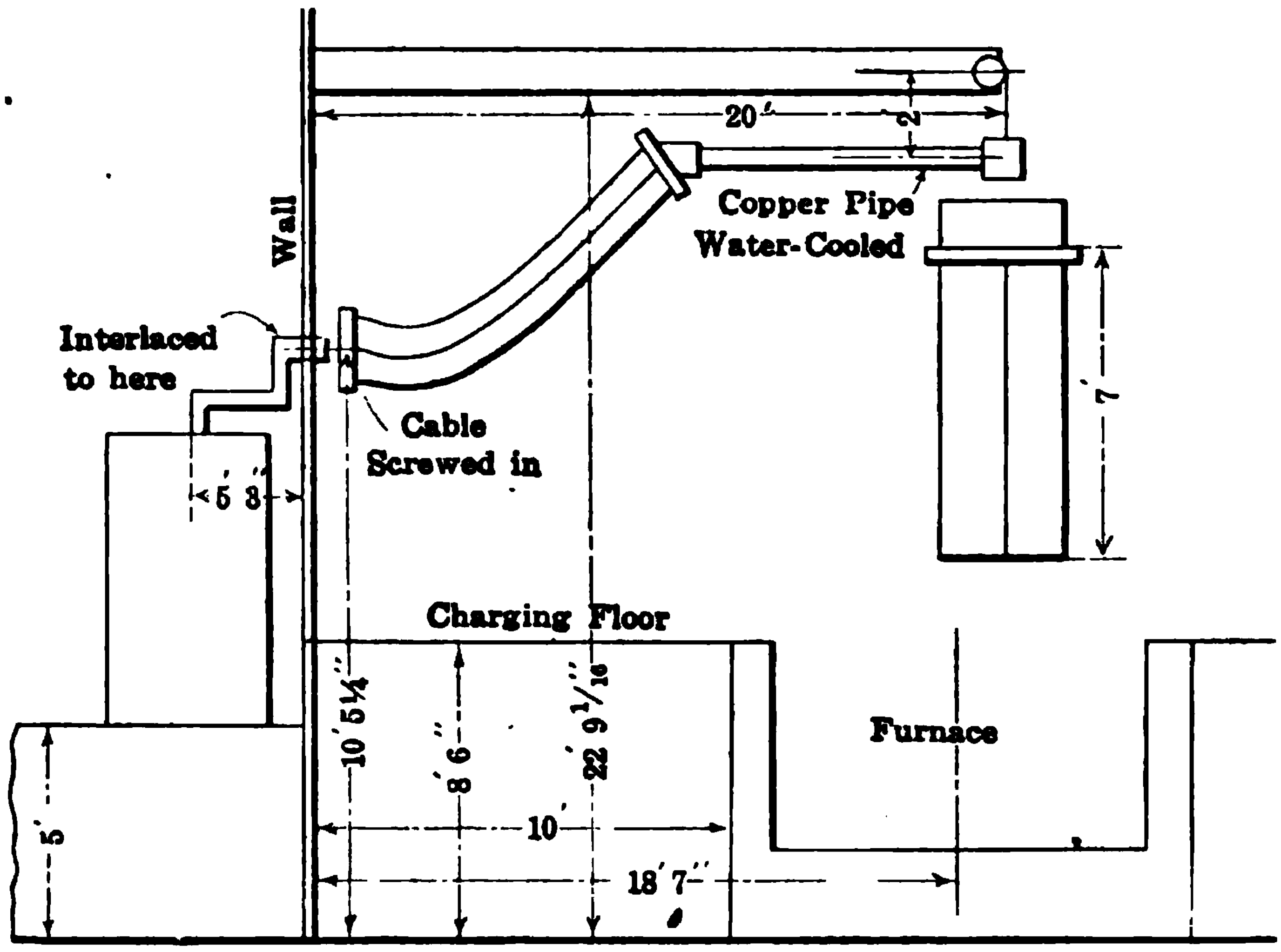


FIG. 1.—FURNACE B.

(including interlaced copper strap between transformer and flexible lead). Dimensions of these parts of the circuit are as follows:

	Electrode	Holder	Flexible Lead
l	345 cm.	282 cm.	305 cm.
d	192	192	192
R	40.9	7.62	18.15
L'	763 $(10)^{-9}$ henry	1453 $(10)^{-9}$ henry	1276 $(10)^{-9}$ henry

$L' = L - M$, and is the effective inductance of the conductor, taking into account both mutual and self-inductance, as previously outlined.

The reactance, in ohms, of any circuit may be calculated by the formula: $X = 2\pi fL'$ where f is the frequency and L' the inductance, as above.

Using this formula, the reactance of the electrode, holder, and flexible lead, on 60 cycles, is calculated as 0.001318 ohm. To allow for the reactive drop in the transformer and interlaced copper strap connections,

a reactive drop of 15 per cent. was assumed at full load. This means that with 30,000 amperes flowing into the furnace per phase, and 160 volts between phases, that is 92.3 volts between each phase and neutral, the reactive drop would be $0.15 \times 92.3 = 13.85$ volts. To obtain the reactance, this reactive drop in volts was divided by the current in amperes, giving 0.000462 ohm. Adding this to the reactance found for the electrode, holder, and flexible lead, a total reactance for the furnace circuit of 0.00178 ohm was obtained.

As such calculations are necessarily but approximations, it is important to be able to check by tests on similar furnaces. In this case, tests on two other similar furnaces were fortunately available. These were furnace *A* which operates at 158 volts, 25 cycles, and furnace *B* which

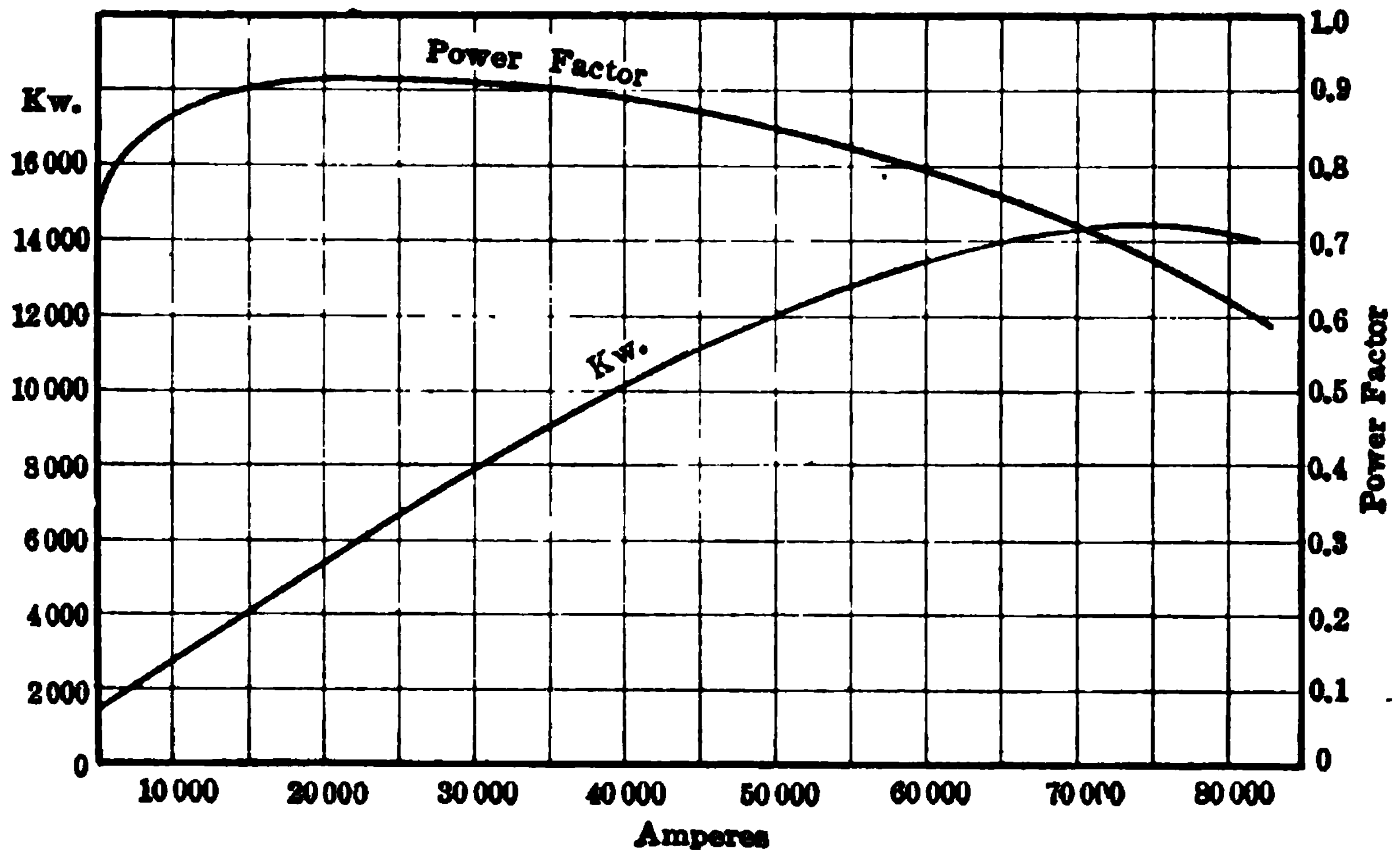


FIG. 2.—PERFORMANCE OF FURNACE *A*. 25 CYCLES.
(Transformer exciting current equivalent to 4620 low-tension amperes.)

operates at 97 volts, 60 cycles. The performance curves for these two furnaces are given in Fig. 2 and 3. It will be noted that furnace *A* operates at practically the same voltage as the proposed furnace, though at a different frequency, while furnace *B* operates at the same frequency though at a different voltage. By analysis of the test curves, Fig. 2 and 3, the reactance of the furnaces was determined as 0.00205 ohm for furnace *B* and 0.000741 ohm for furnace *A*. Correcting the value of reactance for furnace *A* to 60 cycles, it is 0.001775 ohm. It happened, however, that the overall power factor shown on the curve for furnace *A* included the transformer exciting current, which was in the neighborhood of 15 per cent. of the full-load current value. Such an exciting current is abnormally high for furnace transformers, and in the layout for the proposed furnace it was planned to use transformers having so small an exciting current as to have a negligible effect upon the power factor.

Taking the power factor shown on the curve for furnace *A* at 60,000 amperes (which current corresponds at 25 cycles to 25,000 amperes at 60 cycles) as being due to reactance only and no exciting current, the reactance of furnace *A* would be 0.000934 ohm; correcting this for 60 cycles, the value is 0.00224 ohm.

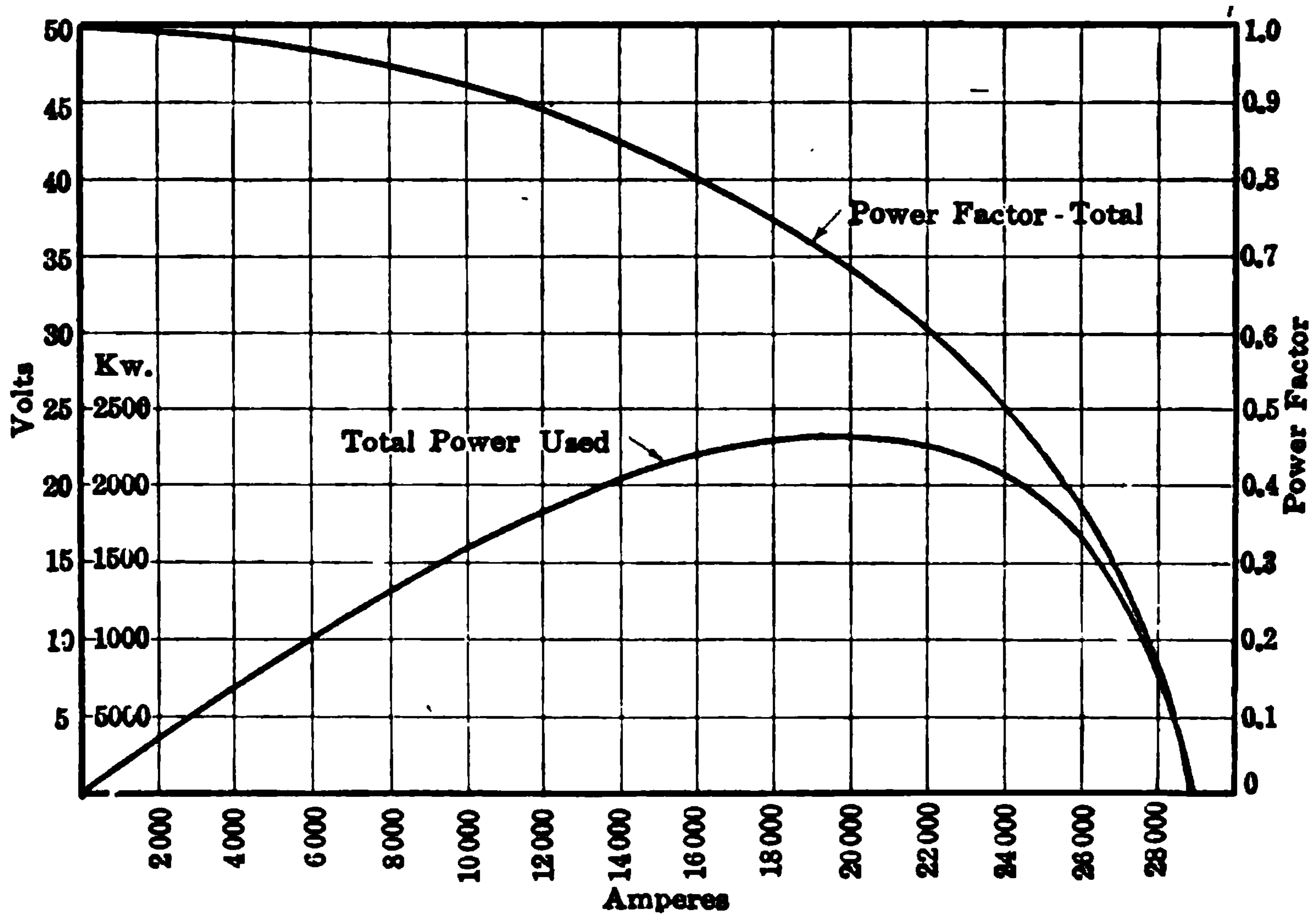


FIG. 3.—PERFORMANCE OF FURNACE *B*. 60 CYCLES.

In comparing the three furnaces, their dimensions were considered with regard to their effect on inductance, remembering that inductance varies directly with the length of the circuit and with the logarithm of the ratio of separation to radius of conductor. The dimensions of the furnaces, as far as available, are as follows:

	Proposed Furnace	Furnace *A*	Furnace *B*
Electrode length	11′ 4″	10′	
Electrode section	18″ × 54″	15″ × 60″	
Electrode separation	5′ 0″	7′ 6″	4′ 9″
Electrode holder length	9′ 3″	11′ 3″	
Electrode holder section	6″ dia. tube	7¼″ × 10″	
Flexible lead length	10′	11′ 6″ to 19′ 6″	
Reactance at 60 cycles	0.00178 ohm (calculated)	0.00224 ohm (test, modified)	0.00205 (test, modified)
Total length of one leg	30′ 7″	....	29′ 2″

It will be noticed that the calculated reactance of the proposed furnace is less than the total reactance of the other two. The electrode separation on the proposed furnace is less than on furnace *A*, and the flexible

leads are shorter, so that the inductance should be less. The total length of circuit for the proposed furnace is slightly greater than that of furnace *B*, and the separation is also greater; so that, provided the cross-section of the circuit is the same, the proposed furnace should have higher inductance than furnace *B*. Since no data were available on the section of the conductors used for furnace *B*, it was felt that 0.0021 ohm would be a conservative figure to employ as the value of the reactance of the proposed furnace, taking into account the test and data on furnace *A*.

The performance of the proposed furnace, calculated with the reactance of 0.0021 ohm, is shown by the curve in Fig. 4, compared with the test curves of the other two furnaces modified to a uniform basis of 160 volts, 60 cycles. The tests on furnace *A* were changed to correspond to

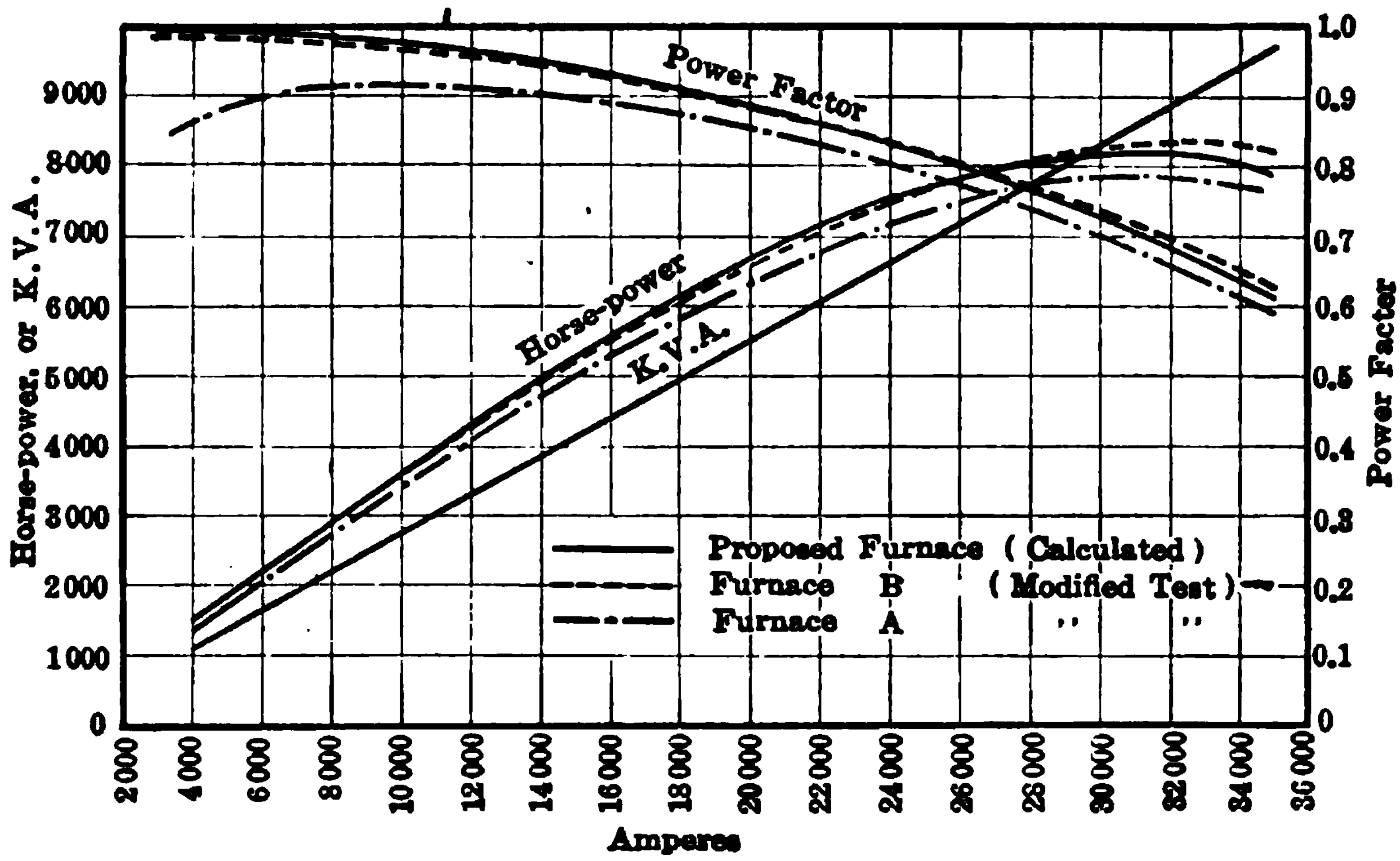


FIG. 4.—COMPARATIVE PERFORMANCE OF 160-VOLT, 60-CYCLE FURNACES.

the proposed conditions by reducing the current in the ratio of 60 to 25. This should give a fair comparison of power factor for the reason that, since the voltages are the same in both cases, the reactance voltage drop would be the same for the same power factor. Since the reactance voltage drop is proportional to the product of current and frequency, if the current is changed in the inverse ratio to the frequencies, the reactance voltage should remain the same. The test results on furnace *A*, modified in this manner, are plotted in Fig. 4, with the calculated performance of the proposed furnace.

In order that the test results on furnace *B* might be on a comparative basis, they were treated as follows: Since the operating voltage of furnace *B* is 97 while that of the proposed furnace is assumed as 160, a given power factor would allow only (97 ÷ 160) times as much reactance voltage drop in furnace *B* as for the proposed furnace. Certain current

values were chosen on the curve for furnace *B* and the corresponding power factors were tabulated. The reactance factor corresponding to a given power factor is, of course, the sine of the angle whose cosine is the power factor. Multiplying the reactance factor by (97 ÷ 1.73) gave the reactance voltage drop per leg. This reactance voltage drop was then multiplied by the ratio of the voltage (160 ÷ 97) in order to obtain the corresponding reactance voltage at the same power factor and at 160 volts. Since this reactance voltage is equal to the product of the current and the reactance, and since the reactance of the proposed furnace is approximately equal to the reactance of the furnace *B*, the ratio of the current which will flow into the new furnace to the current flowing into furnace *B* is the same as the ratio of the reactive voltages, which again is the same as the ratio of the voltages, that is 160 to 97. The curve for furnace *B* modified for 160 volts is shown in Fig. 4 together with the curves for furnace *A* and the new furnace.

The above is simply an example of the way in which heavy-current furnace problems may be worked out. The important thing is to have plenty of test data to refer to for check purposes. As shown by Fig. 4, the maximum useful input which the furnace under consideration could possibly take would be in the neighborhood of 31,000 amperes at 160 volts, approximately 71 per cent. power factor, 3 phase, which would be 8600 k.v.a. or approximately 6000 kilowatts.

Acknowledgment is gladly made to R. H. Willard, who, under the writer's direction, made the detailed analysis of test results and the calculations for this furnace.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

Notes on Certain Ore Deposits of the Southwest

BY W. TOVOTE, E. M., TUCSON, ARIZ.

(New York Meeting, February, 1919)

THIS paper is based upon 12 years' experience in the Southwest, including three years that were spent in constant traveling as examining engineer for the Phelps-Dodge Corporation. The material was gathered during rather extensive work in Bisbee, Clifton-Morenci, Globe, and Tombstone, and also on short and rapid trips into most of the mining camps and prospect fields of New Mexico, Arizona, the desert country of California, and as much of Sonora as was safe at the time. My methods of observation and my deductions are not put forward as new or scientific; they are simply rough field methods, based upon short notes, rough sketches, and largely upon memory, which I have found useful for coördinating geological data for the purpose of passing quick judgment on mining possibilities in certain districts exhibiting uniform characteristics. The opportunities for observation have been better these last few years than ever before, due to the unprecedented activity in mining, which has caused the reopening of hundreds of old mines and the starting of even more numerous prospects all over the mining States.

Possible Systems of Classification

By Geological Provinces

There are a number of well defined geological provinces in the territory under discussion, and a study of their individual features is of interest. The following are a few of those that are most striking in their uniformity.

1. The "Desert province," extending roughly from Wickenburg, Ariz., to and beyond Barstow, Cal. In its north-south extent it reaches up to the Colorado River and down into Sonora, but overlaps other provinces. It is characterized by a worn-down basement of schistose and granitic rocks, on which rest remnants of Paleozoic and pre-Paleozoic sediments, including very old limestones. The sediments are disrupted and contorted. Alteration in the mineralized areas is very prominent, especially in the schists and limestones. Cenozoic volcanic rocks, principally of semi-basic composition, have been intruded into this complex and sometimes cover it as lava flows.

2. The "Yavapai schist" province, similar to the one first mentioned, consists of metamorphosed basic and semi-basic rocks. It lies in northern

Yavapai and Gila counties, having Jerome and Mayer as principal mining centers.

3. The territory of the great lava fields in north and central New Mexico.

4. The "Red Beds" in the same district.

The outlines and the characteristics of these provinces help somewhat toward understanding the mines and prospects in them, but I have found it to be of only slight advantage to classify ore deposits according to their geological provinces, because too many widely differing deposits are likely to be found in the same geological district.

By Form of Ore Deposits

Classification according to the form that an ore deposit has assumed may serve for purposes of subdivision, but it is of little practical use because the form is merely accidental, depending upon the structure and chemical properties of the invaded country-rock, and the factors of stress and depth of burial. In consequence, a number of different forms may occur in a single camp. Some of the most prominent forms are: (1) Veins. (2) Lodes, intermediate between veins and disseminated deposits. (3) Disseminated deposits. (4) Infiltration deposits. (5) Contact-metamorphic deposits. (6) Replacement deposits. (7) Detrital deposits.

The ore-forming agencies react differently in different rocks. The same fracturing force would produce a trunk-channel in a granitic massive, but a stockwork of interlocking fissures, or a lode, in porphyry; it would cause lamination in schist, or devious and quickly cemented breaks in limestone; it might almost disappear in plastic shale but break through brittle quartzite in a series of compound cracks. Thus the same mineralizing activity might produce a vein in granite, a disseminated or lode deposit in porphyry, an infiltration deposit in schist, or contact metamorphic or replacement deposits in limestone; it might form rich ore zones at the contact with shale, but remain barren in them, and cause irregular stringer veins and replacements in quartzite.

By Composition of Originating Magma

Disregarding detrital deposits, all ore deposits in the Southwest show an intimate connection with igneous rocks, and the different types of intrusives have produced certain unmistakable characteristics in the resulting ore deposits, no matter in which geological province they may occur. A classification according to the igneous mineralizing rocks has more elements of universal adaptability for this limited area than any other system that has been tried. It would not be applicable, of course, to a wider territory, because well established types are known elsewhere

which, according to the best authorities, do not reveal any connection with igneous sources.

Igneous Rocks

In field work, and for the purpose of this paper, I dispense with the standard appellations of the igneous rocks, except in rare unmistakable cases, and use instead the following classification:

1. Ultra-acid rocks: quartz dikes and quartz-pegmatites.
2. Acid rocks: having prominent quartz as a constituent, like granites, quartz-monzonites and quartz-diorites.
3. Semi-acid rocks: light-colored, with little or no quartz.
4. Semi-basic rocks: dark-colored, corresponding roughly to the monzonite and diorite families.
5. Basic rocks: dark colored, embracing diabases, gabbros, basalts, and related rocks.
6. Ultra-basic rocks: amphibolites, pyroxenites, peridotites, and rocks abnormally rich in iron.

All these groups of rocks have been found in connection with ore deposits, but No. 2, 3, and 4 are by far the most important.

Structural variations are designated as: Holo-crystalline, or granitic; semi-crystalline, or porphyritic; dense, or rhyolitic; aphanitic, or glassy.

Periods of Volcanism, Periods of Ore Deposition and Systems of Fracturing

Igneous activity in the Southwest was concentrated in several distinct periods, accompanying and following great continental changes. The oldest of these, in pre-Paleozoic times, is of little interest in this discussion, because no ore deposits can unmistakably be connected with it; even those the origin of which antedates the Mesozoic era are extremely rare, and proof of their age is not above doubt. Two periods of volcanism stand out preëminently:

1. The Mesozoic Era, ranging from late Cretaceous into early Tertiary.
2. The Cenozoic Era, or Tertiary period.

Mesozoic Igneous Rocks

The Mesozoic period was inaugurated by the "great Cretaceous transgression" which swept over an old continent and buried it beneath the sea. The igneous rocks of this period are mostly granitic, less frequently porphyritic, in texture, and the horizons now exposed were at one time overlain by strata, long since removed. All types of rocks are represented, but acid, semi-acid and basic magmas prevail. The acid rocks have the widest distribution as well as the greatest importance as

mineralizers. Ultra-acid rocks appear with some of the less important deposits. Basic and semi-basic intrusives seem to have produced ore only in a few places, and even there their importance has been questioned. For these reasons, I shall not attempt a further division of the Mesozoic ore deposits according to their mineralizers.

Tertiary Igneous Rocks

The Tertiary period witnessed a gradual recession of the ocean and the emerging of a new continent. The change was not as abrupt and universal as that of Cretaceous time, but was the result of a series of oscillations. The volcanic activity accompanying it was very widespread and intense. Its products are the mighty lava fields, still impressive after ages of disruption and erosion, besides volcanic necks, bosses, and intrusive dikes.

Magmas of all compositions are represented, but acid, semi-basic and basic magmas prevail. The texture is principally rhyolitic, less frequently porphyritic or glassy. The sequence is generally: 1. Semi-basic; 2. Acid; 3. Basic. In some localities, the cycle has been duplicated, in others only a part of it was developed or has survived. This produces some apparent or actual inconsistencies in the relative age of the different rocks. The varying acidity of the mineralizing magmas has afforded strikingly different characteristics of their respective ore deposits; I therefore subdivide the Tertiary ore deposits as follows:

1. Andesitic deposits, caused by semi-basic mineralizers. 2. Rhyolitic deposits, caused by acid mineralizers. 3. Basaltic deposits, caused by basic mineralizers.

There is a marked difference between Mesozoic and Tertiary deposits, even when produced by mineralizers of similar composition. This is due partly to different conditions in temperature and depth, and partly to the varying length of time during which modifying agencies have been able to work on the deposits.

Systems of Fracturing

The forces which produced both the volcanism and the great continental changes radiated, in all probability, from certain well defined centers, and acted in the same general direction over wide sections of the country. It is therefore not surprising that the different periods show a marked preference for certain directions of fracturing, as now indicated by the respective porphyry dikes and veins. Of course this is not an invariable rule, because great uniform rock masses, like batholiths, caused deviation of the fissuring. In other places the fracturing force may have had a local origin, for instance, a detached volcano. In other places, the exception may be only apparent, a dike having been deflected from its normal course by a preëxisting fault, or ore-forming agencies deviated by

such channels or by favorable rocks. In spite of many exceptions, actual and apparent, I have time and again noticed a coincidence between direction of fracturing and age of the occurrence, and, in otherwise doubtful cases, have even considered the direction a factor in determining the age of a deposit.

Mesozoic fracturing is principally in northeast-southwest direction; Cenozoic-andesitic fracturing favors northwest-southeast; and Cenozoic-rhyolitic favors north-south and east-west fracturing.

The Mesozoic Ore Deposits

The Mesozoic ore deposits of the Southwest include most of the largest and well known mines, especially those of copper. Bisbee, Globe, Clifton-Morenci, Miami-Inspiration, and Ray, in Arizona, Chino in New Mexico, La Cananea in Sonora, belong in this group; also, probably, the Burro Mts., Organ Mts., and San Pedro districts in New Mexico and the Twin Buttes district in Arizona, but in these latter cases a younger mineralization has possibly supplemented the original Mesozoic mineralization.

Acid intrusives of the quartz-monzonite type are most prominent. Basic mineralizers are indicated in Globe and in parts of the Clifton-Morenci district. The fracturing is normally in N.E.-S.W. direction. The volcanic activity was of long duration; in Clifton-Morenci and in the Twin Buttes district, Cretaceous strata have been invaded by the monzonite; in Bisbee they have not. Many of the districts do not show the intrusives and the Cretaceous strata in juxtaposition, and the exact age of the intrusion cannot be determined.

The ore deposits are principally those of moderate temperature, but a few high-temperature deposits are known. Many of the districts began by working contact deposits, probably of high-temperature origin, but their present-day importance depends on ores which do not indicate deposition under conditions of either great stress or high temperature. The mines are scattered over a series of islands of older rocks, emerging from the surrounding lava fields or gravel-covered valleys and mesas. The prospective area is much smaller than that of the more recent periods of mineralization. The ratio of successful mines to the total number of prospects is high. Remineralization by descending waters has proceeded for a long time, and oxidation, kaolinization, and kindred processes, are far more complete than in the younger deposits. The mineralogy is generally very simple, often almost uninteresting, except for the changes wrought by secondary processes.

Pegmatitic Deposits

Pegmatitic deposits connected with ultra-acid dikes are known, but are not of great economic importance; for instance, the tungsten veins

near Johnson Camp, copper-molybdenite and tungsten veins in the Hualpai Mts. and Aquarius Range, Ariz., in whose vicinity stream-tin has been found. Bismuth is encountered in the veins occasionally; tourmaline is frequent in the veins, but not in the ore shoots. Closely related are copper-zinc veins in the Hualpai Mts., in granite-schist country-rock with actinolite as prominent gangue mineral. The universal gangue is naturally quartz, sometimes with orthoclase and muscovite. Rare minerals reported from these deposits are: Arizonite, possibly only a gadolinite, well-crystallized molybdite, and huebnerite intergrown with bismutite. Deposits of this type are considered as of high-temperature origin. Bismuth deposits in the San Andres Mts., New Mexico, probably also belong in this group, but are not decidedly pegmatitic in origin. They are found in laminated schist, and a number of rare bismuth minerals are reported. Ore high in bismuth has been stoped, but the economic importance of the occurrence remains to be proved.

Contact-metamorphic Deposits

Deposits of this nature gave the start to a number of the greatest mining centers in the Southwest. Some of these, after exhausting the contact deposits, now work on different types of ore; others continue in the original type. The mineralogy of the contact-metamorphic deposits is the most variegated among the Mesozoic deposits so far as gangue minerals are concerned; the metallic mineralization is uniform and simple. Both have been exhaustively described. Exceptional instances are the occurrence of bismutite and bismutinite in Organ, New Mex., in connection with contact-metamorphic copper ores (Memphis mine), fluorite gangue (Bennett-Stephenson mine), and intimate intergrowth of galena and epidote (Modoc mine); but the mineralization in the Organ Mts. district has been decidedly influenced by porphyritic intrusions younger (possibly Tertiary-rhyolitic) than the main quartz-monzonite which produced the contact metamorphism. How closely contact deposits are interlinked with other types, and therefore how unsatisfactory are former systems of classification, is shown in most of the principal districts. The following incomplete list of districts shows the prominent forms in which the ore deposits occur:

Bisbee.—Contact deposits, metasomatic, or replacement, and disseminated deposits.

Clifton-Morenci.—Contact, replacement, disseminated, and vein deposits.

Pinal Mts. district, comprising Globe, Miami-Inspiration, Ray, and Christmas.—Contact, replacement, vein, and disseminated deposits.

Chino.—Contact, replacement, disseminated, and vein deposits.

Twin Buttes.—Contact, replacement, and lode deposits.

San Pedro.—Contact and replacement deposits.

Organ Mts.—Contact, replacement, and vein deposits.

All these districts are principally copper producers. The only straight lead contact deposit is in the Modoc mine at Organ. Lead-zinc mineralization is found in most of these copper districts, sometimes important, sometimes so overshadowed by the copper production that it remains practically unknown. Where lead and zinc occur, their ores usually follow the outer edge of the mineralized area. Extensive deposits of lead or zinc, or lead and zinc, principally as replacement deposits, are known in Bisbee (Copper Queen and Shattuck); Globe (Irene mine), here also in veins (Powers Gulch); Chino (Hanover and Vanadium); Cananea; San Pedro; Twin Buttes; and Organ Mts.

The distinctive metallic minerals of all the deposits of this group are pyrite and chalcopyrite, frequently bornite in copper deposits, and galena and sphalerite in the lead-zinc deposits. Tetrahedrite and enargite are found in the veins, but not often. Gangue minerals are primarily quartz and sericite; secondarily, kaolin, sericite and sometimes calcite. Hematite is found in the rare deposits which might be ascribed to basic mineralizers. Gold and silver are low, as a rule, and seldom have an important bearing on the value of these deposits, even in the lead mines, where silver is normally most prominent. Secondary enrichment of copper ores is strongly developed. Chalcocite is the principal product; covellite is mentioned from several places and I have seen it in Bisbee, Morenci, and Twin Buttes. Secondary concentration of the precious metals is practically unknown.

The Disseminated Copper Deposits

These, which are probably the best understood examples of Mesozoic ore deposition, deserve separate mention, not because they are genetically an independent type, but simply to emphasize their characteristics in contrast to those of the less understood disseminated copper deposits of more recent (Tertiary-rhyolitic) age.

The basis of these deposits is pyrite, and pyrite with a slight admixture of chalcopyrite; the mineral chalcopyrite itself is rare in these ores, although it occurs at Ray, Ariz. Primary mineralizing agencies caused silicification and deposition of white vein quartz and sericite. Primary ore is not of economic grade except in narrow veins or feed-channels. The economic value of the deposits is confined to a horizon of limited vertical extent, bounded above by the oxidized zone and below by the primary ore, and is the product of long-continued secondary enrichment. This horizon is defined by the partial or complete replacement of the pyrite by secondary chalcocite. The outcrops of these deposits are very prominent; the surface shows rusty discoloration, quartz seams, and copper-stained quartz cliffs. Skeleton quartz weathers out frequently over large areas.

Below this is a leached and thoroughly kaolinized horizon, usually bare of copper; this grades into lower and less impoverished zones, which have retained part of their copper in oxidized form, highly concentrated locally. The upper part of the leached kaolinized zone is usually white. Iron oxide remains in the cap-rock and is found in veins and seams in the kaolin. Pyrite, probably of secondary origin, but usually considered residual, is found quite frequently immediately above the chalcocite horizon, in conjunction with hydrated quartz. The values are in the copper only; gold and silver are practically negligible. The ground is very soft, and dilution of the ore by mass-stoping becomes a serious factor. The ore worked ranges from less than 1 per cent. up to slightly over 2 per cent. copper.

Considering the Mesozoic deposits as a whole, what impresses me most is that their genesis, the pegmatitic deposits excepted, must have been an exceedingly slow and long-continued process. While the first ore may have been formed under high temperature, deposition continued under steadily diminishing heat, until a very moderate temperature prevailed during the last stages of primary deposition. Almost immediately thereafter, secondary processes began, and continued active through long geological ages. The present-day aspect is, therefore, very complex.

The Cenozoic or Tertiary Ore Deposits

The ore deposits of this period originated close to the surface and their genesis is intimately connected with the volcanic activity which produced the great lava flows. They are rarely an integral part of such flows (basaltic deposits) and usually originated after the lava had consolidated and undergone fracturing. Still, even in these cases the ore deposition must have been compressed into a very short time and while the mineralizing magma, at least in its deeper parts, whence the metallic constituents rose, was far from cooled. Many deposits were completely formed before the next lava masses were poured out above them. Base metals are sometimes important, but are always accompanied by considerable values in precious metals; by far the greatest number of deposits owe their importance almost exclusively to their gold and silver contents. Secondary enrichment of base metals is almost unknown, but a secondary concentration of the precious metals is found frequently. The deposition must have proceeded rapidly and under active volcanic conditions. This is one reason why I cannot fully accept Lindgren's argument for the moderate-temperature origin of these ores; most of the accompanying gangue minerals are stabile over a very wide range of temperature.

Three types of deposit are clearly distinguishable, differing in age, origin, and characteristics: the basaltic, the andesitic and the rhyolitic.

Representatives of these types cover a much larger territory than the Mesozoic deposits and, while their present importance does not equal that of the older group, their prospective possibilities are very great. In the early mining days in the Southwest, their importance was preëminent, but the old bonanzas have been worked out, and the abandoned mines are now mostly inaccessible. Most of the prospects seen in the ordinary run of field work belong in these groups.

Basaltic Ore Deposits

These are the youngest and the least important of the Tertiary deposits. They really are of geological importance only, not of economic value. I have seen only a few representatives of this group, mostly in New Mexico, near Steeple Rock, Grant County, and near Bland, Sandoval county. Large areas of basaltic copper deposits are reported from the Mogollon Plateau, from which I have seen specimens.

The primary mineralization consists of nuggets and flakes of native copper, imbedded in usually vesicular, basaltic lavas. The vesicles are either filled with chalcedony and quartz, or are empty and lined with a greenish mineral, an iron compound (probably kraurite) which is frequently mistaken for impure chrysocolla. This type of deposit can assume economic importance only in exceptional circumstances, such as secondary concentration in gash veins; here, chrysocolla and malachite, subordinately azurite, cuprite, native copper, or even chalcocite are formed. Calcite is the principal gangue. The veins give out at shallow depth.

Andesitic Deposits

Andesitic deposits are found, in conjunction with rhyolitic, over the entire area under discussion, from the Colorado line into southern Sonora, and from Texas into California. Very frequently, both types are represented in the same general district, but many districts belong distinctly to one type to the exclusion of the other.

Andesitic deposits are usually connected with fracturing in N. 60° W. and N. 20° W. directions. The fracturing seems practically contemporaneous and the veins frequently drag one another, producing intermediate directions. Intersection points and dragged sections are loci for ore shoots. The andesite is often metamorphosed to semi-schistose structure in the ore-bearing areas, but usually can be traced back to fresh and unaltered dikes.

Prominent districts representing this type are: The "Parker Cut-off" country in Yuma county, Ariz., and San Bernardino and Riverside counties, Cal.; the lead-zinc belt near Kingman and Chloride, Mojave county, Ariz.; the Casa Grande section in Pima and Pinal counties,

Ariz.; the Tularosa country in Otero county, New Mex., and others. I believe that most of the copper deposits in the Red Beds in New Mexico derive their metallic minerals from andesitic sources.

Important mines of this type are: the Tennessee, near Chloride; the Golconda, in Union Basin, near Kingman; the Clara Consolidated, near Swansea, Yuma county; and the Planet mine, a little farther west on the Bill Williams River; the famous Monte Christo mine, near Wickenburg; and the Lakeshore mine near Casa Grande.

Gangue minerals are: hematite, chlorite, baryte, frequently calcite and dolomite. Quartz is subordinate; where found, it is often very recent. Fluorite is rare. Kaolinization and sericitization occur, but are not nearly so important or conspicuous as in the Mesozoic deposits. Serpentinization and propylitization are important. Kaolinization, if found, is usually accompanied by deposition of chalcedony in roughly banded structure. Copper, while often important, is never so predominant as in the Mesozoic deposits. Many districts are prevailingly lead-zinc producers. Gold and silver are always present in economically important quantities, and may become the main object of mining, always accompanied by base-metal values.

The mineralogy of these deposits is variegated and interesting. It comprises, besides the sulphides of the base metals and their oxidation products, the sulph-arsenides, sulph-antimonides and sulphides of silver, with their derivatives. Beautiful specimens of flaky, or even crystallized, free gold have been found, sometimes intergrown with hematite or calcite.

The andesitic deposits frequently have very conspicuous outcrops. The neighborhood of the Planet mine, in Yuma county, for example, shows some of the most wonderful outcrops to be found anywhere, being actual mountains of hematite and limonite, stained green by the salts of copper. In other places, outcrops are marked by the bleaching of normally purplish andesite. Here, high-grade oxidized copper ore is not an exception close to the surface, underlain by barren, partly kaolinized andesite. As a general rule, copper ore and copper stain at and near the surface have led to the prospecting and discovery of many mines, which ultimately were found to contain copper only as a negligible accessory. Some outcrops are misleading; there are wide areas of copper-stained andesite, which have even been considered worth testing by churn-drilling, but have been found to contain only tight and narrow veins below. Many an outcrop, standing out as an imposing reef, covers insignificant and unremunerative veins; while, on the other hand, very inconspicuous croppings hide some of the biggest orebodies. This is especially true where chlorite is the main gangue mineral. Chloritization and propylitization are the safest indicators of deep-seated mineralization; hematite, while attractive and conspicuous, is not always reliable.

The Rhyolitic Deposits

The rhyolitic deposits comprise a wide variety of both precious and base-metal orebodies. Some of the most important representatives are:

Tombstone, Ariz.—Silver and gold derived from tellurides and sulpho-salts; also combined in the sulphides of lead, zinc, and copper. Alabandite is found; quartz and fluorite are prominent gangue minerals.

Prescott and Vicinity, Ariz.—Chalcopyrite and pyrite, seldom bornite, with quartz and orthoclase, and such carbonates as dolomite and ankerite.

Crown King, Ariz.—Sphalerite, galena, and pyrite, with very little chalcopyrite, in quartz-carbonate gangue; high silver values are probably due to admixture of sulph-antimonides.

Oatman, Ariz.—Free gold, with practically no base metals, in calcite and chalcedony gangue. Adularia is a frequent gangue mineral.

Mogollon, New Mex.—Argentite, finely impregnating quartz, accompanied by gold in some form, and sometimes associated with bornite and chalcopyrite. Fluorite and carbonate minerals are the gangue.

Black Range, New Mex.—Bornite and tetrahedrite, with high-grade silver minerals, like argentite and stephanite, in quartz-fluorite-carbonate gangue. Cuproplombite is reported from here, and I found crystallized bornite.

Nacozari, Sonora, is a prominent example of the rhyolitic ore deposits; and the *Patagonia-Nogales* country furnishes more representatives.

Most of these rhyolitic deposits owe their origin to volcanic disturbances, far more violent and abrupt than those connected with the previously described deposits. Brecciation is usually very pronounced and in many cases has been repeated at least once. Ore deposition began apparently under high temperature, but probably not high pressure, and continued through periods of diminishing temperature. The fracturing is north-south and east-west, usually a little east of north and north of east. Ore shoots are almost universally due to intersections, and very seldom to a single factor.

Gangue minerals are: Quartz and chalcedony, often replacing older carbonate gangue minerals. Carbonates, like dolomite, ankerite, rhodochrosite; seldom siderite. Calcite is among the first (pre-mineral) as well as among the last (post-mineral) depositions. Fluorite is very frequent; baryte rather rare. Zeolites are typical, especially stilbite; orthoclase or adularia, often in well defined crystals, and rhodonite are common. Molybdenite, usually in large flakes or even sharp crystals, is a common metallic associate; nephelite has been found, and zinnwaldite and other rare micaceous minerals, as well as amphiboles, sometimes occur.

The metallic minerals comprise most of the sulpho-salts of both precious and base metals and their alteration products. High-grade silver

minerals frequently seem associated with amethyst, the latter being a good indicator.

In Santa Cruz county, Ariz., I found a type of deposit which I believe has not been described. It is characterized by the somewhat rare micaceous mineral zinnwaldite (silvery white, lithia-bearing and crystallizing in rosette-shaped crystals). The zinnwaldite occurs in masses of crystalline aggregates as well as in well defined columnar crystals. Sometimes it forms narrow ribbons in veins of banded structure. It is always closely associated with metallic sulphides (chalcopyrite principally) and sometimes with rutile, both massive and in splendid crystals. The country-rock is the younger quartz-monzonite.

In another place in this same vicinity, I found a vein in the monzonite which had, besides zinnwaldite and coarsely crystalline molybdenite, an intimate mixture of magnetite, apatite, pyrite, and chalcopyrite.

Many deposits of this period are pockety, but some mines have developed large and persistent ore shoots. Sudden changes are the rule, unexpected swelling or pinching, and fabulously rich bonanzas surrounded on all sides by poor and weak vein sections.

The disseminated copper deposits of rhyolitic age are sure to become important. Nacozari, Sonora, is the principal representative, followed by Red Mountain, near Nogales, and Copper Basin, near Prescott, Ariz. Possibly Ajo, Ariz., belongs in this group, but I am not familiar with the latter district. The ore is found in fractured and brecciated rock, rich ore occurring in the breccia zones. Metallic sulphides have pervaded the rock generally along narrow cracks and fissures, and as impregnations. The country-rock is generally acid (quartz-porphyry to quartz-monzonite). Mineralization begins with silicification, closely followed by pyritization, these processes often being duplicated. Toward the end of the first period of pyritization and during the second period, chalcopyrite is deposited. Molybdenite is a frequent accessory, and carbonate minerals, zeolites, orthoclase or adularia, form the principal gangue, besides the more conspicuous quartz. Amphibole, rare micas, and nephelite are found occasionally.

The ore is strictly primary; secondary enrichment (chalcocitization) is practically unknown. The copper is mostly deposited as a very pure chalcopyrite, sometimes with bornite, but is also occluded microscopically in the pyrite. Gold and silver are always present in economically important quantities. The sulphide remains unaffected by oxidation close to, and even at, the surface. Superficial indications commensurate with those of the Mesozoic "porphyries" are the exception. Secondary rock alteration is confined to a shallow belt near the surface, and along prominent fissures; elsewhere the rock remains hard and fresh.

The grade is rather low, but I feel confident that these deposits will prove economically valuable in the near future. At this time, dis-

seminated ore of 1 per cent. Cu, and less, without accessory gold and silver, is treated in some of the older "porphyries," a grade far below that of some of these rhyolitic deposits.

The Jerome District

My previous omission of the Jerome district has been intentional, because I have not enough data from my own observation to define the age of these deposits. Generally, the ore at Jerome is considered very old. F. L. Ransome apparently considers it pre-Cambrian, because he mentions eroded pyritic deposits in the basal schist as the probable source of the ferruginous coloring in the pre-Cambrian Tapeats sandstone. This view is supported by the appearance of the 600-ft. level of the United Verde Extension, where the Paleozoic sediments seem to rest upon an eroded schist surface, containing remnants of an oxidized orebody. Still, this evidence does not seem conclusive to me, because the oxidized ore here might possibly be a later deposition, derived from mineralized surface waters, which found a ready precipitant along this contact.

The fact stands out preëminently that the pyritic deposits in the schist have escaped the metamorphism undergone by the country-rock. They do not show any stratification or lamination, and are therefore later than the metamorphism, which formed schist out of the original basic and semi-basic volcanic rocks.

While no ore has been found in the Paleozoic sediments overlying the schist, a strong contact metamorphism and some indication of mineralization are noticeable on the south side of the Black Hills, on whose north slope Jerome is situated, and this contact metamorphism is closely connected with minor ore deposits, identical in type with the Jerome ore.

In the United Verde Extension, the ore is found in veins striking N. 10° to 20° E., but the bonanza orebody is at the intersection of such veins with a northwest-southeast cross-vein, or fault. This fault seems to have had a decided influence upon the mineralization, and the fault material suggests derivation from semi-basic intrusive rocks. From the information available at present, I would hesitate to state the age of the Jerome deposit, but am inclined to believe that it is much younger than usually assumed.

Future of the Southwest Mining Industry

As to the outlook for the mining industry in its relation to the three great groups of ore deposits, I venture the prediction that very few new mines of Mesozoic origin will be found in the Southwest. Those that will come into prominence eventually will be mines known today, but enhanced in value by the progress of mining and metallurgy, or extensions of known and operating districts, or new deposits, discovered by accident.

The Tertiary deposits, on the other hand, are by no means developed to their full capacity. I look for many mines of andesitic origin and even more of rhyolitic derivation to become prominent in the near future. Still, very few of these will compare in size and richness with the great Mesozoic mines, so far as base metals are concerned. This seems to be in keeping with the general trend of recent development in the mining industry here, where great mines are more and more concentrated in the hands of a few big companies, while beside them has sprung up a healthy undergrowth of small operators. The small mine and the combination of small mines seem to be destined for increasing importance.

Prospecting of the old days is dead. How closely the whole country has been searched is brought home, time and again, when in places where hardly a rattlesnake could live, and where there is no indication of human habitation for miles around, remnants of old workings and prospect holes are found. Good discoveries are still made quite frequently, but as the result, usually, of highly intelligent development work. It is regrettable that, on the one hand, the big companies do not more frequently develop small but promising prospects while, on the other, no safer and more business-like method of development appeals to the public at large than the floating of 1,000,000-share development companies.

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

Cement Plugging for Exclusion of Bottom Water in the Augusta Field, Kansas

BY H. R. SHIDEL,* AUGUSTA, KANS.

(New York Meeting, February, 1919)

THIS paper summarizes the results obtained from the preliminary cementing of wells in an effort to cut off the bottom water. The object of this work was two-fold:

(1) To prevent the oil sand from becoming flooded.

(2) To plug off bottom water, thereby preserving the individual well and reclaiming production.

Valuable suggestions and help have been given by the following named: Messrs. Kyle and La Velle, of the U. S. Bureau of Mines; Magnolia Petroleum Co.; Freed Oil and Gas Co. The cementing work was carried out under the personal supervision of L. J. Snyder.

In an unpublished paper on the "Water Problem in the Augusta Field," S. K. Clark reaches the following conclusions:

(1) That the great amount of water present is bottom water, occurring in the Varner sand, the main producing or the 2500-ft. horizon.

(2) That the only striking connection between structure and water is in the area of the marked fault on the Ralston, E. C. Varner, and F. Varner leases in sections 8, 9, 16 and 17.

(3) That the oil occurs in porous streaks, generally separated by fine-grained, well cemented sand, which is barren. Possibly two or three such pay streaks may be found. That under a pay, fine-grained sand occurs, which is presumably barren at the time of drilling, but soon reveals water.

The writer takes partial exception to the last point, because well defined shale, slate, lime, or hard sand breaks have been encountered in a great many cases, separating the pay streaks under which water is often found. This is not an invariable occurrence, as cases have been noted when the oil has been followed immediately by water in the same stratum.

In an effort to overcome the water menace, the following methods of plugging were tried:

(1) Plugging with wood, lead, and limit plugs.

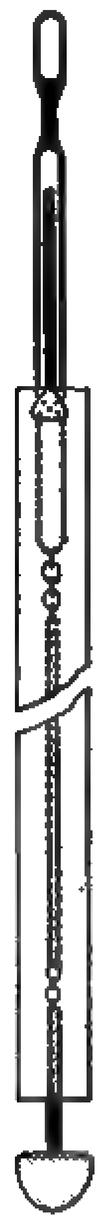
(2) Plugging with sand pumpings.

* Resident Geologist, Empire Gas and Fuel Co.

(3) Mudding the sand, removing the packer, and driving a limit plug.

(4) Cementing.

A few variations of the last process will be discussed on the following pages. The success obtained by the above methods has been variable. In some places the plugging has been remarkably successful temporarily, as in the early efforts on wells of the Penley lease. In a few instances, as Brown No. 4, Sec. 16, the plugging was decidedly effective in improving both the cemented well and the surrounding ones.



Before Dumping After Dumping

FIG. 1.—DETAIL OF TRIP BAILER.

MOYLE NO. 4, SEC. 10

This well produced a large percentage of water for some time. A limit plug was driven at the bottom of the well but proved unsatisfactory. In driving the plug through the shale-lime break much material was broken off, thus forming an imperfect seal. It was then decided to cement. A trip bailer was constructed (Fig. 1) and enough cement was put in the well to fill it to the top of the break. This cementing sealed the hole with material having practically the same character as the shale-lime formation.

The cement was allowed ample time (14 days) to set before the well was pumped. The results of this test were satisfactory, as can be seen from the relative percentages of oil, B. S., and water produced before and after cementing (Table 1).

TABLE 1.—*Moyle No. 4, Sec. 10*

Before Cementing				After Cementing			
Date	Oil	B. S.	Water	Date	Oil	B. S.	Water
Apr 19, 1917	33	7	60	Jan. 9, 1918.	94	2	4
May	32	3	65	Feb. 6	[illegible]	1	1
Aug.	6	0	94	Mar. 21	98	1 5	0 5
Sept.	17	1	82	Apr. 18	98	1	1
Oct.	[illegible]	0	77	May 16	99	1	
Nov.	Well cemented.			June 7.	100		
				June 20	99.5	0 5	

Brant No. 3, Sec. 2, Twp. 28S., R. 4 E.

The cementing of this well proved so unsatisfactory that it was drilled out and re-cemented. Drilling out and cementing was done three times during one week. Other methods were tried, in an effort to shut off bottom water temporarily. A packer was placed but failed to work, although sufficient mud had been forced in to shut off the water. The cement was then put in on top of the mud and a limit plug was driven

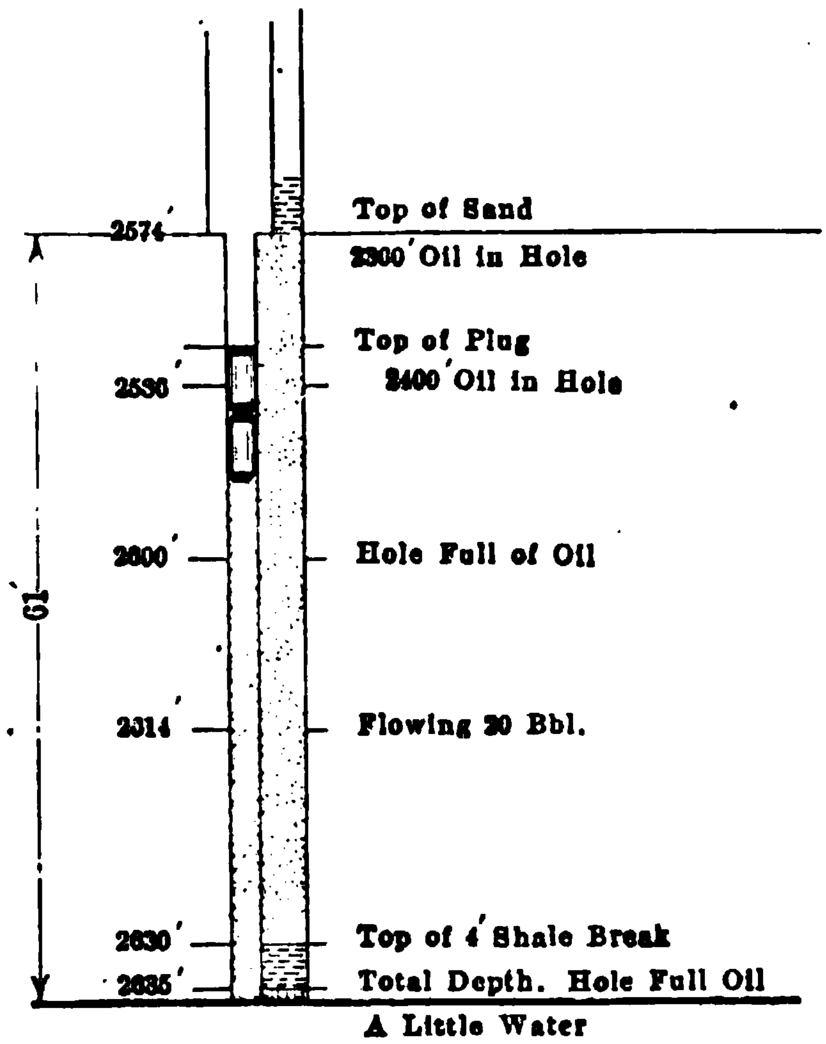


Fig. 2.—Brant No. 3. Cement, limit plugs and character of sand when drilling in.

into it; a second limit plug was then driven on top of the first. This job has been successful, as shown by the behavior of the well before and after (Table 2).

Table 2.—*Brant No. 3, Sec. 2*

Before Cementing				After Cementing			
Date	Oil	B. S.	Water	Date	Oil	B. S.	Water
Apr., 1917	18	2	80	Feb. 21, 1918	20	..	80
May	19	4	77	Feb. 23	16	..	84
Sept.	9	..	91	Feb. 25	8.1	1	91
Oct.	15	..	85	Apr. 19	Well cemented again.		
Nov.	11	..	89	May 17	44	4	52
Jan. 22, 1918	Plugged with cement.			May 23	70	25	5.0*
				June 20	80	14	6

* Average of 10-min. tests.

Scully No. 6, Sec. 28

This well was cemented to the top of a shale break and a limit plug was driven in the top of the green cement. The well was put to pumping, three days after cementing, with unsatisfactory results. The relative percentage of oil, B. S., and water were as shown in Table 3.

Table 3.—*Scully No. 6, Sec. 28*

Before Cementing				After Cementing			
Date	Oil	B. S.	Water	Date	Oil	B. S.	Water
Aug. 4, 1917......	3	..	97	Mar. 29.........	50	..	50
Sept. 21..........	5	..	95	Apr. 4...........	24	3	73
Oct. 15...........	..	..	100	Apr. 18..........	10	..	90
Feb. 8, 1918......	..	..	100	May 16.........	4	..	96
Mar. 25..........	Well cemented.			May 31..........	3	..	97
				June 20.........	2	..	98

The results point conclusively to the fact that 14 days should be allowed for the cement to set.

Scully No. 9, Sec. 28

The same procedure was again followed in this well, which started to pump water before the flow of oil. At first the well flowed at the rate of 500 bbl. per day, but gradually diminished; the average production

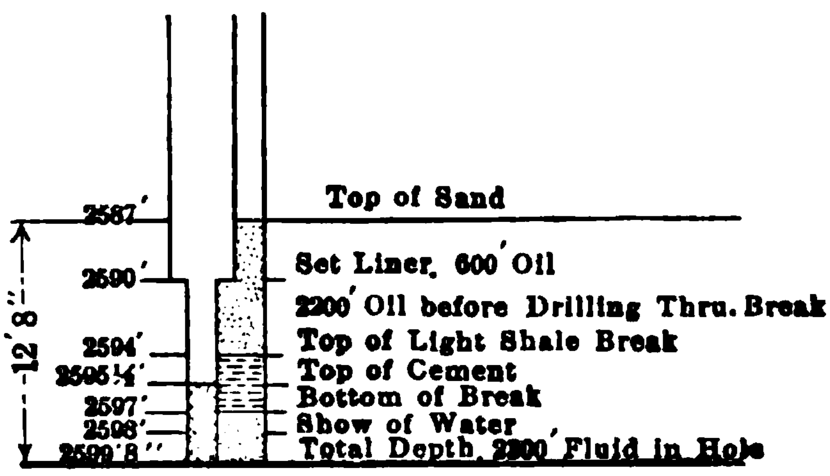


Fig. 3.—Moyle No. 23. Cement and character of sand when drilling in.

during 60 days was 75 bbl. The well is now pumping about three times as much water as oil.

Moyle No. 23, Sec. 10

A good top pay was encountered (Fig. 3), followed by a shale break under which was water. The well was then cemented to 2595.5 ft., but this work proved unsuccessful, as the well has produced a high percentage of water since cementing. After testing, the cement was proved

to be of a poor grade, so that this work has to be done over. Since cementing, the well has produced about 40 per cent. of oil.

CUNNINGHAM No. 6, SEC. 16

This well was cemented April 1, 1918, the top of the cement being at 2491 ft. The results are shown in Table 4.

TABLE 4.—*Cunningham No. 6, Sec. 16*

Before Cementing				After Cementing			
Date	Oil	B. S.	Water	Date	Oil	B. S.	Water
Sept. 5, 1917....	3	...	97	Apr. 25, 1918....	75	....	25
Oct. 31..........	3	...	97	May 7..........	79.6	3.2	17.2
Jan. 17, 1918....	...	...	100	May 15..........	97	2	1
Mar. 14..........	11	...	89	June 1..........	81	12.5	6.5
				June 13..........	84.5	1.0	14.5

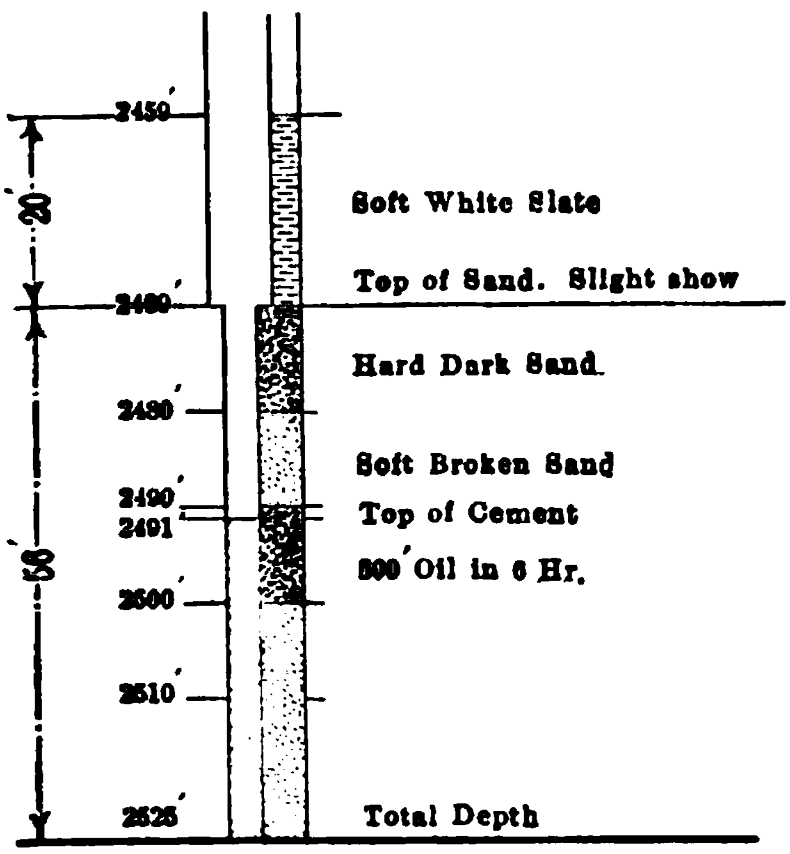


FIG. 4.—CUNNINGHAM No. 6. CEMENT AND CHARACTER OF SAND WHEN DRILLING IN.

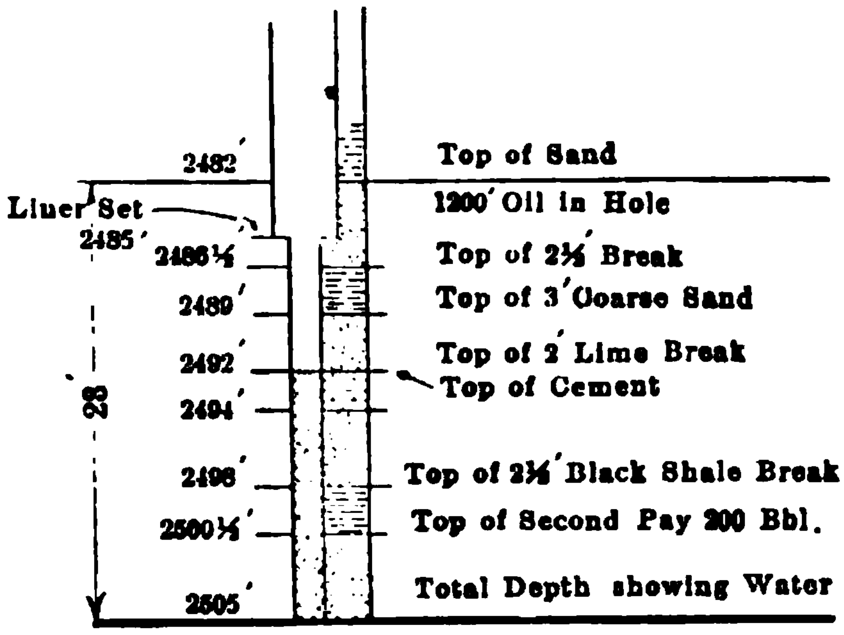


FIG. 5.—SCULLY No. 10. CEMENT AND CHARACTER OF SAND WHEN DRILLING IN.

SCULLY No. 10, SEC. 9

Two pays were encountered, which were separated by distinct breaks (Fig. 5). The second pay showed a little water at the time of drilling. Six days later, one sample gave 100 per cent. water while an average of an 8-hr. sampling tested 72.4 per cent. water. This well was cemented to shut off the bottom pay, and since then has produced very satisfactorily, as shown in Table 5, yielding 3 to 5 bbl. of oil per hour.

TABLE 5.—*Scully No.* 10, *Sec.* 9

Before Cementing				After Cementing			
Date	Oil	B. S.	Water	Date	Oil	B. S.	Water
Mar. 26, 1918....	26.6	1.0	72.4*	May 1, 1918.....	99	1	
Mar. 25..........	.....	.....	100	May 2...........	98.5	0.75	0.75
Apr. 10..........	Well cemented.			May 4...........	95.1	3.0	1.9
				May 6...........	98.3	0.9	0.8
				May 7...........	97.8	1.6	0.6
				June 12.........	100		
				June 19.........	98.9	.....	1.1
				July 1..........	98.5	.....	1.5

*Average of 8-hr. testing.

MILLER NO. 7, SEC. 2

It was decided to mud the sand before cementing. A packer was placed and a pressure of 500 to 600 lb. was applied continuously for three

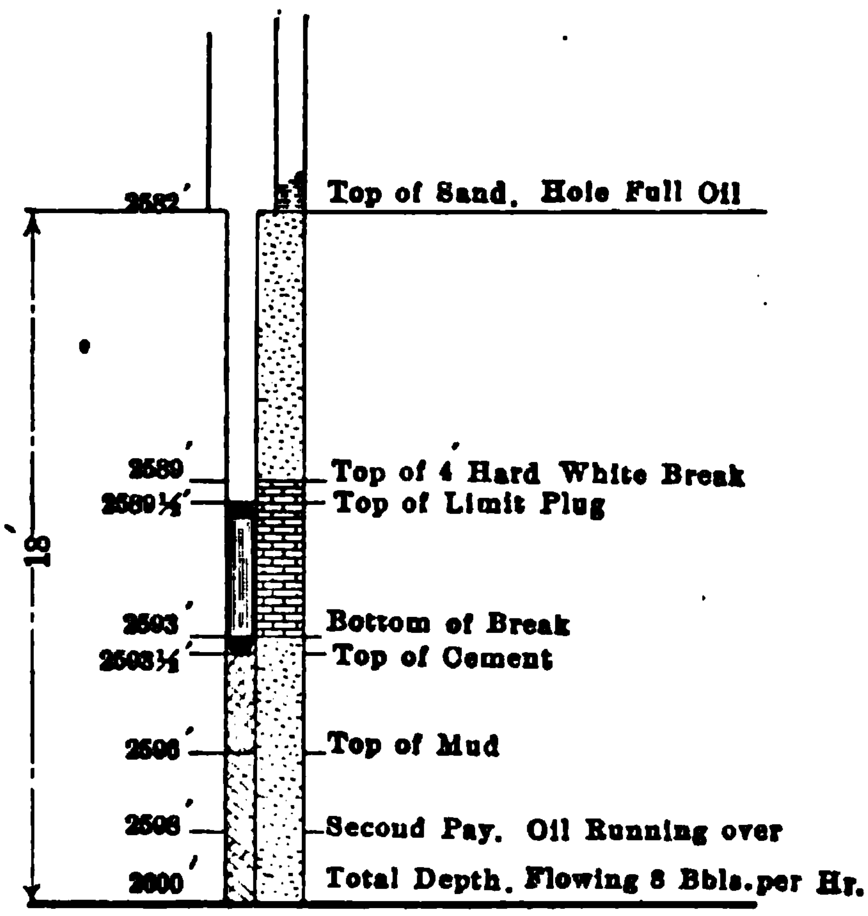


FIG. 6.—MILLER NO. 7. CEMENT, LIMIT PLUG AND CHARACTER OF SAND WHILE DRILLING IN.

days. A limit plug was driven in, but did not hold. One-fourth sack of cement was then put in, and a limit plug was driven in it (Fig. 6). The well was allowed to stand for a while and was then pumped. The results before and after were as shown in Table 6.

The results of the cementing of the 13 wells were as follows:

1. Six were very successful, in that the water was shut off in the well itself and production was reclaimed.

2. Four were successful, in that the percentage of water produced was decreased. One of this number is to be cleaned out and re-cemented.

TABLE 6.—*Miller No. 7. Sec. 2*

Before Cementing				After Cementing			
Date	Oil	B. S.	Water	Date	Oil	B. S.	Water
May, 1917	31	16	53	Mar. 11, 1918	96	2	2
Aug. 10	10	1	89	Mar. 14	29	37	34
Sept. 5	8	...	92	Mar. 18	56	42	2
Oct. 13	9	...	91	Mar. 20	83	16	0.5
Nov. 6	5	...	95	Mar. 21	84	16	0
Jan. 19, 1918	7	...	93	Mar. 23	91	8	1
Feb. 8	13	...	87	Mar. 25	82	27.5	0.5
Mar. 11	Cemented.			Mar. 26	74	25	1
				Mar. 30	98.5	0	0.5
				May 2	62.0	32	6.0
				May 23	54.0	46	

3. One was successful, in that, while the well continued to produce water, it also produced an average of 75 bbl. per day for two months. It was producing no oil before cementing.

4. In one well, oil and water were plugged off, and when an effort was made to drill out the cement a strong flow of water was encountered. The sand was so flooded that it was decided to abandon the well. The cementing of this well caused an increase of production in the nearby wells.

5. One was successful, in that the amount of water produced was diminished to a few barrels, and an offsetting well began producing oil.

6. Four of the wells cemented did not give satisfactory results, as the proportions of oil and water produced were practically unchanged. These wells are to be abandoned as non-productive, after it is proved that the sand is flooded.

7. One was a complete failure. The cement was drilled out and the second operation was very encouraging, as an increase of production was noted. This well is to have more work done on it.

8. One well was cemented so high that it has to be drilled out and tested.

9. One well was proved to be no longer productive, and is to be abandoned.

Nine wells have not been tested as yet.

Preliminary attempts to shut off the bottom water by cementing have been successful in most cases. There are certain disadvantages to be considered, although they are generally overbalanced by the advantage.

Disadvantages of Cementing

1. The process may cement oil sand as well as the water.
2. The well has to be shut down 10 or 14 days.

3. The cement has to be carefully tested for setting qualities.

4. If but a few feet of sand are to be cemented, generally some means have to be taken to keep the cement from being agitated. Driving a temporary plug and mudding the sand have been tried.

Advantages of Cementing

1. The cement assumes the same shape as hole; it does not leave cavities.

2. There is no pounding or jarring, thus preventing shattering of the sand.

3. The cement can be partially or entirely drilled out if unsatisfactory. Cement drills about the same as a lime formation.

4. When pressure is applied the cement will penetrate the sand and seal it.

5. The amount of cement to be placed can be carefully gaged. One sack of cement fills 7 ft. in a $5\frac{3}{16}$-in. hole and $5\frac{1}{2}$ ft. in a $6\frac{5}{8}$-in. hole.

It is estimated that to clean out and cement a well costs $600. In all of the successful cases, this cost was returned in a few days. The wells in which production was not reclaimed showed sufficient evidence to warrant abandoning; all casing and other equipment could then be removed.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

Water Troubles in the Mid-Continent Oil Fields, and their Remedies

BY DORSEY HAGER* AND G. W. MCPHERSON,† TULSA, OKLA.

(New York Meeting, February, 1919)

THE rapid increase of water troubles in the Mid-Continent oil fields is causing much alarm. Troubles occur at Towanda, Eldorado, Augusta, Cushing, Blackwell, and Healdton, although they had not been acute in the Mid-Continent field until about two years ago, when the unusual conditions in the deeper oil fields were first encountered. California faced the same situation, but, thanks to aggressive measures, has largely overcome the dangers.

The following analysis of water trouble may throw some light on the subject and be of assistance in solving the problems involved.

WATER TROUBLES CLASSIFIED

The presence of water in large quantities in oil sands has the following results:

1. Diminishes oil production.
2. Diminishes casing-head gasoline production:
   (a) By curtailing the gas flow.
   (b) By making the use of vacuum pumps unsuccessful.
3. Increases lifting costs:
   (a) By making it necessary to pump large quantities of water, which requires a fast motion and long stroke (third hole).
   (b) By requiring the use of compressors for air lift.
   (c) By causing break-downs and delays due to the high speed necessary to pump water.
   (d) By making it necessary to treat "cut" or emulsified oil.

Oil production is seriously curtailed by the presence of large quantities of water. Lease records show that wells are shut down 40 to 60 per cent. of the pumping time where serious water trouble occurs. While a small quantity of salt water may cut the paraffine and keep the oil moving, several hundred feet, or a hole full of water, effectually "kills" the oil

* Petroleum Geologist and Engineer.
† Production Expert.

and gas. The quick return of wells to production, once the water is shut off, shows how wells have been affected. The killing of gas sands naturally means a decrease in gas volumes. Also, where the hole is full of water, vacuum pumps are worthless.

When attempts are made to pump off the water, the wells must be pumped fast and with a long stroke (third hole). This results in rapid crystallization of the rods, in numerous breaks, and in much belt trouble, all causes of expensive delays. Some operators have installed air-lifts to pump off water in great quantities; this calls for expensive compressors. and $1 to $2 per barrel of oil for lifting expense is not unusual. The treatment of "cut" or emulsified oil also calls for considerable extra equipment and expense.

Some Results Obtained by Shutting off Water

It is necessary only to give a few results obtained by shutting off water to show how important this procedure is.

The Ohio Cities Oil Co., on its Sina Crow lease in the North Cushing oil field, Oklahoma, cemented more than 12 wells. These wells made from 3 to 20 bbl. of oil apiece before shutting off water, and all the water that could be pumped, ranging from 100 to 150 bbl. per well. After cementing, these wells showed increases of 10 to 150 bbl. of oil, and yielded only 1 to 10 bbl. of water; in fact, some wells made none. The casing-head gasoline content increased from 400 gal. to over 1400 gal. per day. Lifting expenses were greatly reduced, as the well pumped 90 to 100 per cent. of the time instead of 40 to 60 per cent. By eliminating water, all the principal troubles ceased.

Classification of Water

In nearly all oil fields, water is found to occur at some place in the oil sands. This water may lie immediately below the oil and in the same sand *throughout all* of the oil pool (bed *D*, Fig. 1), or it may occur around the edges of the pool (*B*, Fig. 1). It may also lie below the oil, but in a different stratum (*C*, Fig. 1). Water may also occur in sands above or between oil horizons (*A* and *C*, Fig. 1).

In California, Wyoming, and areas of steep dips, it is most unusual to find water in the oil sand near the center of the pool. However, in the Mid-Continent field, where low dips are the rule, water is often found in the same sand as the oil, even in the heart of the pool (bed *D*, Fig. 1). Water in the oil sand is found around the edges of all Wyoming and California oil pools; this is known as "edge" water Water below the oil sand is generally called "bottom" water (beds *C* and *D*, Fig. 1); and water above is called "top" water. The writer prefers the terms "primary" and "secondary" waters.

Primary water may be defined as water that was present in the oil sand before drilling occurred; it includes "edge" water and "bottom" water, where there is no break in the sand. All water entering the oil sands from above, between, or below, may be termed secondary water, and its entrance is made possible only by the drilling of oil-wells. Top water, and also bottom water, in lower sands come under this heading.

As the oil and gas are drawn from the oil sands, primary water generally replaces them. This is because the water is generally under high head, sometimes as much as 1500 lb. per sq. in. This water cannot be exhausted from the sands, but its encroachment can often be checked and so directed that wells need not be abandoned, until most of the

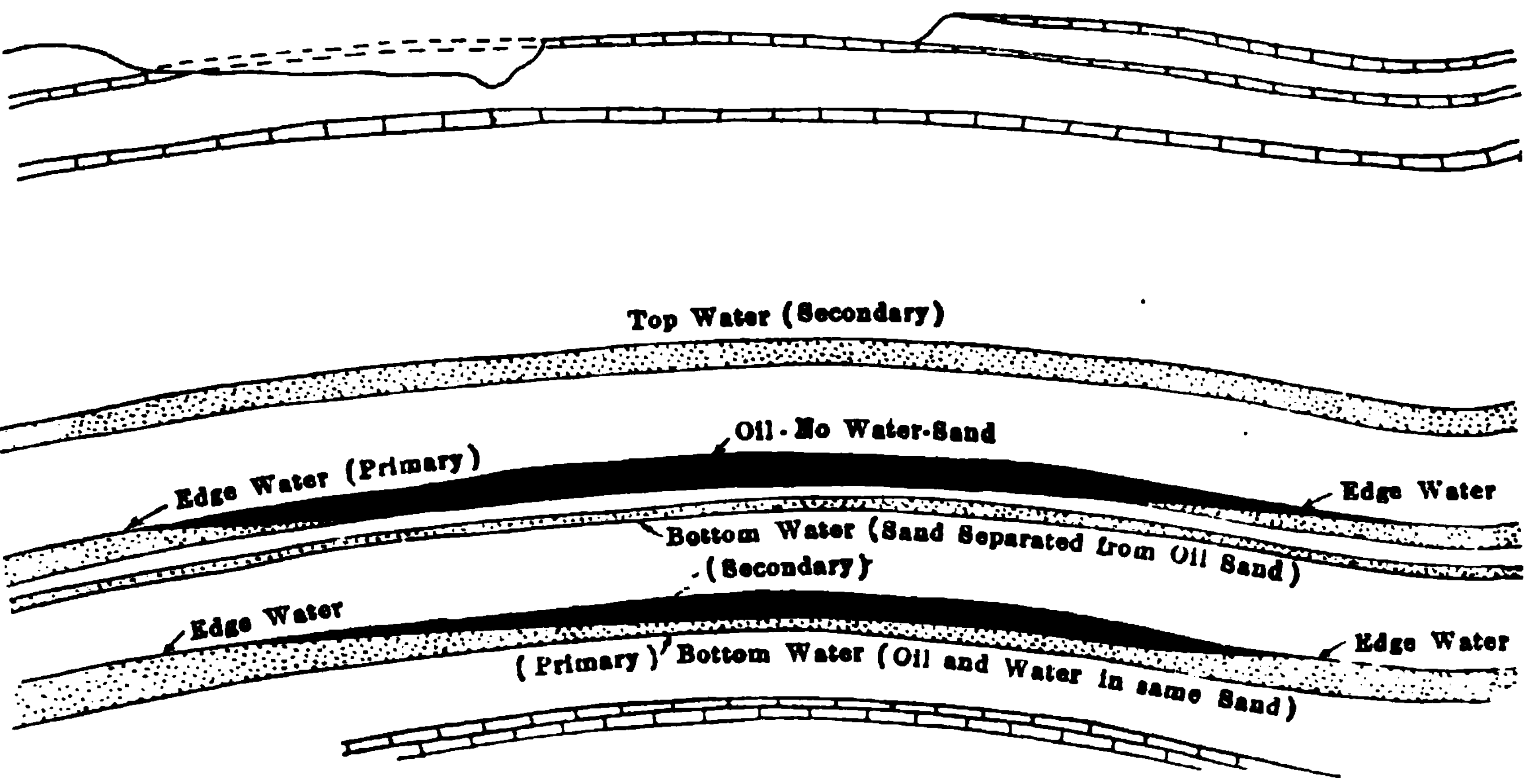


FIG. 1.

available oil is secured. At present, only from 10 to 20 per cent. of our oil is secured, when 50 to 75 per cent. should be obtained.

Fig. 1 illustrates a number of conditions that can and do occur in oil fields, where more than one oil sand is present. These conditions existed before any wells were drilled. *A* is a water sand; *B* carries oil and water; *C* is a water sand; *D* carries oil and water. A condition of equilibrium exists in those sands; there is no travel nor migration of water from one sand to another and the only way to upset this stable condition is to drill wells. Deeper sands often occur, but for purposes of illustration only two oil sands are shown; in some fields, five or six oil sands exist, and numerous water sands.

There is no possible way for primary water at *A* to enter the lower sands without being admitted by drilling. At *B* it is noticed that water is around the edge of the sand. On top of the fold, water does not exist. However, were a well drilled below the *B* sand into the *C* sand, bottom water would be found. This would then be true secondary water. Also, it may be noticed that sand *C* would provide bottom water for *B* and top

water for *D*. Sand *D* shows edge water, which, however, is at the same time bottom water, a condition common to thick sands in regions of low dip like the Mid-Continent. By drilling too deep into the sand this water would be encountered.

Source of Water Flooding

The effect of water flooding may all be the same, but the source of the water may be different.

Well 5, Fig. 2, shows how bottom water may flood a well.

Well 3, Fig. 2, shows how top water may flood a well.

Well 5, Fig. 2, also shows how water between sands may flood wells, when improperly shut off.

Wells 4 and 5, Fig. 2, show how water in one well may flood a neighboring well.

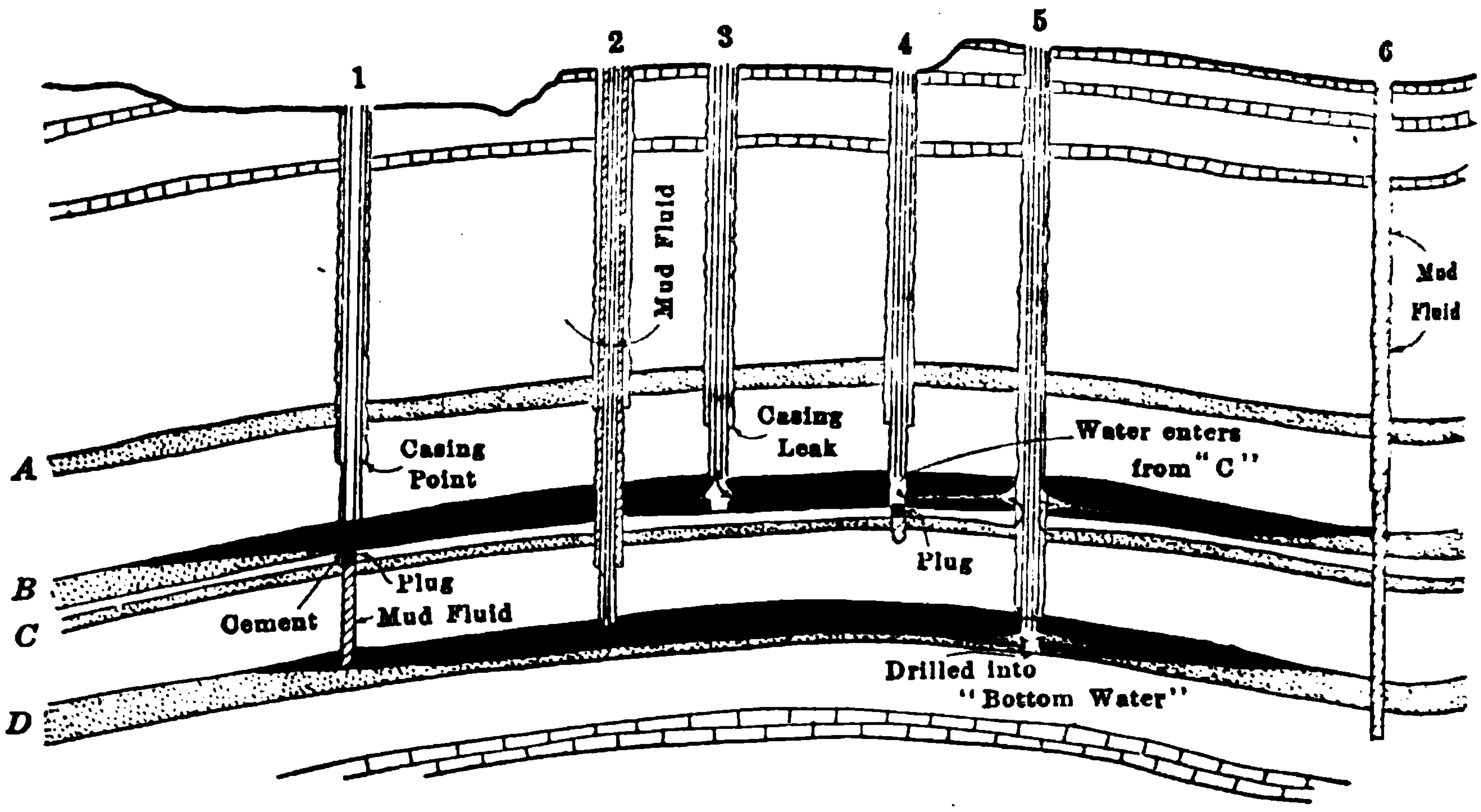


Fig. 2.

To remedy water troubles, it is necessary first to determine the source of the water, but this is by no means a simple matter. In some cases it is quickly ascertained, but in others only careful experiment will decide. Chemical analysis may be successfully employed where the waters show marked differences in composition. Aniline dyes may be used as tracers in some cases.

Remedies for Water Troubles

Once the source of the water has been ascertained, remedial operations must be employed. These remedies may call for total abandonment of wells in some cases, for a change of casing points in others, for new casing, for the use of mud-laden fluid, or for cementing off water. Remedies should be employed with the full coöperation of the oil operator not only of the immediate property but on the adjoining properties.

If a well is so hopelessly flooded that remedial means cannot restore it, and if it is a menace to neighboring wells, abandonment should be ordered. Before abandoning, however, the well should be plugged in such a manner that there is no possible chance for water to use the well as a channel by which the flooding of adjacent wells may still go on. Before leaving a bad well, see that it is filled with mud fluid, of proper consistency, from top to bottom (see well 6, Fig. 2). Mud fluid forms a more efficient seal than any other known means of plugging.

A change in casing points may be necessary where a gas sand or "dry" sand has become a water sand, due to flooding from adjacent wells. In such case, the shutting off of the water may be best accomplished by underreaming the hole to form a new seat, and then using mud fluid or cement in back of the casing.

New casing, of course, is required if leaks have been found in the casing. Casing may be eaten through by acid waters, a common cause, or the casing may have been faulty. Where heavy heads of water occur, any tendency to weakness in the casing may develop into breaks. Collapsed casing, leaks around couplings, or holes in the casing may result.

Mud Fluid

Mud fluid is best used when abandoning wells, or for filling behind casing. Limitations of its use must be clearly understood.

Mud fluid is the name given to a mixture of pure clay with water. The fine clay forms an emulsion with water when the specific gravity of the mixture is not over 1.35. A good mixture has a specific gravity of 1.2 to 1.3. This mud fluid is so much heavier than water or gas that it shuts off gas sands and keeps water back in the sands instead of moving in the drill hole.

Fig. 2 illustrates a variety of conditions. Well 1 was drilled too deep. The lower sand *D* was non-productive, so it was mudded off, and a wood plug and cement seal were set at the bottom of sand *B*. This effectually protects *B* from water at *C*, and the *C* water cannot enter *D*.

Well 2 is producing from sand *D*, and the effectual shutting off of sand *B* by mud fluid is shown.

Well 3 shows how a casing leak will allow water to enter a sand. The remedy is to put in new casing.

Well 4 was drilled to sand *C*, but plugged off successfully. Sand *B* is, however, endangered by wells 3 and 5. The remedy is to shut off water in 3 and 5.

Well 5 shows the improper shutting off of sand *C*, and the consequent flooding of sand *B* from *C*. Also, well 5 shows how, by drilling too deep into the sand, the upper part of sand *D* is threatened. The remedy is to shut off the offending sands.

Well 6, in the syncline, has been abandoned and filled with mud fluid.

Cementing Methods

For shutting off water under pressure, cementing is the best method. The old methods of using wooden or lead plugs, of bottom packers, and of seed bags, are obsolete. These methods work under some conditions, but safety-first requires the use of cement. Cementing methods, which comprise by far the largest part of remedial work, are not so simple as may first appear. Many factors enter into the question, and the average lease boss has neither the experience nor the training necessary to appreciate them all; yet failure in observing any one of them may result in loss. Observation of the following points is essential to success:

1. As little as possible of the pay oil sand must be covered. Many failures have resulted from cementing the pay sand; although water may be shut off, so also may the oil and the gas.

2. The method of introducing the cement must be the one best applicable to the conditions in the field.

3. Care should be exercised in selecting the brand of cement used for this work. In some cases it may be necessary to use accelerators to give rapid sets, but when these are used they must not appreciably weaken the cement.

4. The work must be done as quickly as conditions will warrant. Loss of production and expensive work on wells must be reduced to the minimum.

The system of cementing employed most successfully is the one that takes these factors most completely into account. The introduction of cement has given rise to several distinct systems, all of which seek to attain the same results. These methods are:

1. The bailer dumping method.
2. The tin-tube method.
3. The tubing and packer method.
4. The Perkins method.
5. The McDonald method.
6. The McPherson system.

The bailer method of emptying cement into the hole is the simplest, but least efficient, except where a plug of only limited depth is required. It fails, however, where it is necessary to put cement into a hole that has large gas pressures and moving water.

The tin-tube method, which consists in filling tin tubes with cement, lowering them in the hole, and later crushing the tubes by the drill, is very little used at present.

The four last mentioned methods are the best. They are more or less similar, with enough variation to have distinctive names. In all of them, the cement is mixed in big boxes on the surface and is pumped into the hole through casing or tubing, precaution having first been made

to insure circulation of water. Rotary mud pumps are employed for pumping in the cement.

The Perkins system consists in placing a disk packer in the casing, which is driven down upon the cement and forces all of it from the hole and up behind the casing.

The tubing system consists in gravitating the cement into the hole through open tubing, and letting it settle to bottom. Cement is mixed at the surface and pumped into the tubing; gravity does the rest.

The McDonald system consists in dropping dry cement through the casing or tubing and adding water to it. It is a simple method, especially applicable to shutting off bottom water.

In using the McPherson system, a canvas packer is generally placed in the bottom of the tubing in such a way that, when expanded, it limits the level of the cement, which is pumped through the tubing, to the level of the bottom of the tubing. By using an expanding packer, cement may be pumped under pressure into a shot hole and some of it forced into the pores of the sand. A pressure of 200 to 300 lb. is employed.

The McPherson system differs from the other systems in the employment of special canvas packers in some cases where shot holes are the rule, and by a special device for the cleaning of the walls of shot holes by causing a strong rotative action of the water on the walls of the hole. This action insures a clean surface of the wall of the hole and results in a better contact for the cement.

The Perkins method has met with excellent success in California. The McDonald system has given favorable results in Illinois and eastern fields. Variations of these methods are also employed in the Mid-Continent fields. However, the McPherson system has thus far been the most successful in the Mid-Continent fields, as it has been developed to meet the special needs of that area.

Conclusion

Water flooding in the Mid-Continent is a menace that must be met quickly. Only the active coöperation of the oil operators will save many wells. In California, the oil operators settled their difficulties by coöperating for shutting off water. Some action must be taken in the Mid-Continent, whether it be through private, state, or federal agencies. Common business sense and national conservation demand it.

Origin of the Texas Domes

Discussion of the paper of E. L. De Golyer, "The Theory of Volcanic Origin of Salt Domes," presented at the Colorado Meeting, September, 1918, and printed in Bulletin No. 137, May, 1918, p. 987.

BY E. T. DUMBLE,* B. S., HOUSTON, TEX.

The domes of the Texas coastal plain are structural features, consisting of bosses or stocks of salt, gypsum or anhydrite, or of combinations of these, intruding into and occurring in connection with broken and uplifted sedimentary beds of Cretaceous and Tertiary age. Some of these domes show on the surface as mounds of greater or less elevation, while others are only known from drilling records. They may be divided into two classes: interior domes and coastal domes.

The interior domes include those which occur in a zone 40 to 50 miles in width lying immediately east of the Cretaceous-Tertiary contact, and extending from the Sabine to the Colorado. With a single exception, these domes, so far as now known, occur in approximate alignment with the contact, but at irregular intervals. East of the Brazos, the domes are entirely surrounded by Eocene sediments.

The coastal domes are found nearer the Gulf, lying entirely within Neocene territory and stretching from the Rio Grande to the Sabine. They are much more numerous than the interior domes, and, apparently, are ranged along several lines having a general northeast-southwest direction. No domes are known in the Oligocene belt.

Interior Domes

The interior domes so far identified are Butler's, in Leon county, Palestinē and Keechi in Anderson county, Brooks and Steen in Smith county, and Grand Saline in Van Zandt. In connection with these interior domes we must also consider the Sabine Peninsula, of Harris, which is, without question, genetically connected with them.

The Palestine and Keechi domes have been described recently by O. B. Hopkins,[1] who gives a clear idea of their composition and structure. Others have been described at different times, and an excellent résumé of the literature is given by De Golyer.[2]

---

* Consulting Geologist, Southern Pacific Co.

[1] U. S. G. S. *Bull.* 661 (1917), 253. The Brenham dome, also described in Hopkins' paper, either belongs to same class as interior domes, or is intermediate between them and the coastal domes. It certainly is in no way related to the coastal domes.

[2] *Bulletin* 137 (May, 1918), 987.

The Palestine dome is 6 miles west of Palestine. Here we find a depression of irregular shape, with a maximum diameter not exceeding ¾ mile (1.2 km.). The bottom of the depression is occupied by a shallow lake with its surface 50 ft. (15 m.) below the general level. The banks on the eastern and northern sides slope upward gradually, but that on the west is more abrupt. The lowest rock exposed is a sandstone, which, as proved by its fossils, is of Woodbine age. Between this and the underlying body of salt, 140 ft. (43 m.) below, there is 85 ft. (26 m.) of gray to yellow water sand, 40 ft. (12 m.) of dark gray sandy clay, under which there is in places a cap-rock of hard limestone of varying thickness. Apparently, therefore, the Woodbine rests directly upon the salt mass.

The Woodbine, at its exposure, shows a dip of 46° to the northwest. It is overlain by the Eagle Ford, Austin Taylor(?) and Navarro beds, all of which dip northwest at angles varying from 40° to 50°. No beds were found which can be referred either to the Midway or the Lower Wilcox, the lowest Tertiary beds being sands, clays and lignites belonging to the Middle or Upper Wilcox. According to Hopkins, these Wilcox beds in the vicinity of the dome show southeast dips of 38° to 57°, which decreases within 1½ miles to 20° to 30°, and within 3 miles become normal. On the northeast and southeast the Claiborne beds reach within 3 to 5 miles of the Dome, but show little, if any, change from normal dip.

Six miles (10 km.) northeast of this locality, the Keechi dome shows the Austin Chalk at the surface, surrounded by the Navarro beds, and these are in turn encircled by the Wilcox, which dips away from the dome at angles varying between 20° and 30° (Hopkins). As in the case of the Palestine dome, the Claiborne is 3 to 4 miles northeast and southeast of the Keechi dome.

The thickness of the beds as interpreted from logs of the wells would be approximately 500 ft. (152 m.) for the Navarro and Taylor, 800 ft. (244 m.) for the Austin and Eagle Ford, and 400 ft. for the Woodbine. The salt mass reached at 2200 ft. (671 m.) was drilled into for 900 ft. (274 m.), a 30-ft. (9 m.) bed of water sand being encountered in it at a depth of 2900 ft. (884 m.).

The Butler dome, which is 6 miles (10 km.) southwest of the Palestine dome, has not been so carefully examined, but appears to resemble the Palestine very closely and gives the same geological section. Brooks and Steen domes, in Smith county, are also Cretaceous islands.

Grand Saline, on the contrary, while undeniably of similar origin to these five Cretaceous islands, and a dome in structure, is entirely overlain by the Wilcox and shows no Cretaceous at the surface. Furthermore, the body of salt is more limited and probably not more than ½ mile square. The workable salt here appears as a lens or boss and not as a stock. The salt occurs at a little over 200 ft. (61 m.), and in places

attains a thickness of 300 ft. (91 m.), thinning out at the edges. It is immediately overlain by gypsum, or by alternations of limestone and salt. The beds above these are heavy limestones, shales, and clays, and dips of 30° or more have been observed.

On the surface, the Sabine Peninsula is a belt of the Wilcox, in places more than 30 miles (48 km.) in width, extending along the Texas-Louisiana line from Vivian to Sabinetown. It is flanked east, west, and south by bodies of Lower Claiborne. From north to south, the average surface slope of this peninsula is less than 1 ft. per mile (0.2 m. per km.).

Well sections show the Upper Cretaceous beds dipping southward from Red River at about 50 ft. per mile (9.5 m. per km.) to Vivian. Here the Sabine uplift begins, which brings the Cretaceous up again within 500 to 700 ft. (152 to 213 m.) of the surface. Basing the estimate on the top of the Annona Chalk, the dip of the Cretaceous between Vivian and Sabinetown is 300 ft. or about 3 ft. per mile (0.6 m. per km.). Above the Cretaceous, the sections show 250 ft. (76 m.) of Midway and up to 450 ft. (137 m.) of Wilcox. The well records show that the Cretaceous rocks were folded first along northeast-southwest lines and later at right angles to this.

The Cretaceous of the Peninsula, therefore, instead of continuing on its normal dip, forms a mesa or table-land, and seemingly had this structure during lower Eocene time. Harris suggests that it formed an island during the Claiborne.

Coastal Domes

Beginning on the south we find, some 30 miles (48 km.) north of the Rio Grande and a few miles west of Raymondville, on the St. Louis & Brownsville Railway, an elliptical-shaped lake about 5 miles (8 km.) in circumference with water nowhere exceeding 3 or 4 ft. in depth and a bottom of pure rock salt. It occupies quite a depression in the widespread plain of gray sands, and is known as the Sal del Rey. It is apparently a salt dome, and probably the only one in which the salt occurs at the surface.

The next important dome to the northwest is Loma Blanca in Brooks county, 6 miles southeast of Falfurrias. A lake, 3 miles in length by ½ mile in breadth, lies north of it, the water of which is only a foot or two in depth. Loma Blanca itself covers an area of probably 50 acres (20 ha.), and its top has an elevation of 75 to 100 ft. (23 to 30 m.) above the lake. Its northern side rises somewhat abruptly from the margin of the lake and is covered with a soft, gypseous sand containing blocks and boulders of selenite. The sand thins out toward top of the mound, and near the summit clear, transparent selenite is seen to cover an area of several acres. The selenite is in layers 2 to 6 in. (5 to 15 cm.) in thickness and is perfectly transparent. Wells drilled on this mound show that

the selenite stock has a thickness of more than 1000 ft. (305 m.). Around the foot of the mound the gypseous sand is gradually covered by gray, siliceous sands. The deposit of gypsum evidently underlies a large area, for the lake is bordered on the north for more than a mile by a bluff 25 to 30 ft. high of gypsum sand with blocks of selenite.

Between the Colorado and the Brazos we find some large domes, among which are Big Hill near Matagorda, Bryan Heights, at the mouth of the Brazos, and Damon Mound about 30 miles northwest of the latter. These mounds are prominent features in the Coastal Plain.

Big Hill rises gently from the shores of Matagorda Bay to a height of 36 ft. (11 m.) but dips sharply on its northern side to the level of the prairie. Its surface material consists of yellow Port Hudson clays. It first attracted attention as a probable oil field, and both gas and oil were found, but its production soon failed. The drilling, however, discovered considerable bodies of sulphur along the eastern side of the mound, filling caverns in porous limestone beds at about 1000 ft. (305 m.) in depth. So far as our records show, although salt waters were encountered in drilling, no body of salt has yet been found.

Bryan Heights has about the same elevation as Big Hill, with a diameter of about 1 mile and rather gentle slopes on all sides. The surface is composed of Port Hudson clays, which are apparently 500 ft. (152 m.) in thickness, underlain by 200 ft. (61 m.) of Lafayette and other materials which rest upon a dolomitic cap-rock. Below this there occurs some 300 ft. (91 m.) of gypsum and sulphur with some sandstone. This lies directly upon the salt stock, which is found in the dome at about 1100 ft. (335 m.). In this mound the sulphur is associated with gypsum and anhydrite. The only limestone is the cap-rock.

Wells to the northeast and to the south have been drilled to considerable depths, one of them to more than 3000 ft. (914 m.), entirely in stratified sediments, with no signs of dome materials. In the few fossil forms found in drilling outside the mound, nothing occurs to indicate that the beds are earlier than Miocene.

Damon Mound, in the northern corner of Brazoria county, is much larger than either of the others, covering between 2000 and 2500 acres (809 to 1012 ha.), and rising 80 ft. (24 m.) above the prairie. Its surface is composed of Lafayette sands and gravel, and it thus forms a Pliocene inlier in the Port Hudson.

One of the earlier wells struck gypsum at 171 ft. (52 m.) and continued in it for 400 ft. (122 m.), the bottom 30 ft. (9 m.) being a mixture of gypsum and sulphur. Immediately below this was loose sand and then 500 ft. (152 m.) of rock salt with bottom not found. Subsequent drilling shows that the "gypsum" body is a mixture of anhydrite, gypsum and selenite. Some limestones are found on the sides of the mound and in the wells. Kennedy gives this section of the region near the original well:

Red and blue clays with some heavy beds of sand....	360 ft. (110 m.)
Limestone and gypsum..........................	190 ft. (58 m.)
Gypsum and sulphur..........................	40 ft. (12 m.)
Rock salt..........................	500 ft. (152 m.)

Drilling to the south and southwest of the mound has developed commercial oil deposits in sedimentary beds which seem to dip away from the mound at angles of 30° to 50°. Wells off the mound, but near it, have been drilled to over 5100 ft. (1554 m.) without finding any trace of mound materials.

Stratton Ridge lies 8 to 10 miles (14 km.) northeast of Bryan Heights. Three wells along a line running north and south found gypsum and anhydrite at depths varying from 862 to 1840 ft. (263 to 561 m.), but so far no well has gone through it. No salt, oil or sulphur has yet been found.

Hoskins Mound lies 10 miles northeast of Stratton Ridge. A good production of oil was obtained from the shallow sands on top of the dome. One well drilled to the south encountered the cap-rock at about 800 ft. (244 m.), below which they found over 500 ft. (152 m.) of gypsum and anhydrite with some sulphur. The only fossils found indicate the age of the sedimentary beds to be Lower Pliocene or Upper Miocene.

The Humble dome, which shows on the surface an extreme elevation not exceeding 20 ft. (6 m.), is probably 1½ mile (2.4 km.) in diameter. On top of the dome, gusher oil was found at 1000 to 1200 ft. (304 to 366 m.). The cap-rock, as it is called, is dolomitic and is in places accompanied by gypsum, the two having a maximum thickness of about 200 ft. (61 m.). These rest directly upon the mass of rock salt.

Upon the decline in production of gusher oil from the dome proper, wells were drilled at various distances from it on all sides. The Esperson wells, 1 mile to the south, found light oil in shales, and later, similar oil was found on the north and in larger quantities to the east of the dome. The series of beds in which the oil was found consists of shales and gumbo, with some sand, and dips away from the dome on all sides. Between the producing area on the dome and that of the shale-oil belts on its flanks, there is a strip ½ mile or more in width in which oil is not found in any quantity, and in this the belts are apparently much broken. The salt mass which occurs at 1400 to 1600 ft. (427 to 488 m.) on the dome, was struck at 2320 ft. (707 m.) at the western edge of the shale-oil belt lying east of the dome. This well was drilled to a depth of 5410 ft. (1649 m.) without getting through the salt. To the east of this, wells considerably more than 3000 ft. (914 m.) deep found only stratified materials.

These conditions indicate clearly that the domes comprise an intrusive mass of salt, gypsum, or anhydrite, coming up through the sedimentary beds, which are broken and tilted. The intrusive action is also shown by the sills of salt and gypsum which are found in some of the domes.

No fossiliferous beds have been found in connection with these Coastal Domes that are earlier in age than the Miocene, except in one well at Sour Lake, where Harris found Jackson fossils, and in another at Saratoga in which forms of similar age were reported. No oil was found in either of these wells, and other drillings near them failed to find any extension of these deposits, which are, therefore, seemingly restricted to very narrow limits.

Origin of Intrusives

The association of the gypsum, salt, and anhydrite suggest their derivation from sea water by evaporation. Attention has been called to the fact that the occurrence of the gypsum above the salt in these domes indicates that these substances may have had some other origin, but none of the hypotheses suggested seems to have any better grounds than that of the familiar one of evaporation of brines from sea water, especially as the geological facts indicate the probability of favorable conditions for such formation in this region.

The salt masses of the interior domes lie below the Woodbine. Therefore, their deposition must have taken place prior to the beginning of Upper Cretaceous sedimentation. There were two periods antedating this which were especially favorable for the deposition of gypsum and salt.

Prior to the Comanchean Cretaceous, East Texas was part of a land mass, a region of erosion and not of deposition, with drainage into the epi-continental sea of North Texas. The encroachment of the Comanchean sea was from the west and south, and the character of its sediments, as seen in the extreme eastern exposures in Arkansas and southward into Texas, are those of shallow water, showing that the old land area was but slightly submerged. The Trinity in Arkansas carries considerable beds of gypsum, a condition which was duplicated in West Texas, where, in the Malone mountains, we have hundreds of feet of gypsum of Lower Cretaceous age. There is, therefore, no reason why salt and gypsum deposits of this age may not be expected in the area of northeast Texas occupied by the interior domes.

A second period favorable for such deposits is found in the interval between the Comanchean and the Upper Cretaceous. While we have no such positive evidence of the accumulation of such deposits of sea salts at this period as those already mentioned, the fact that for hundreds of miles the contact between the Buda limestone, which marked the close of Comanchean deposition, and the Eagle Ford (which overlies the Woodbine when the latter is present) shows no signs whatever of erosion, proves that during the long period that elapsed between them the top of the Comanchean must have remained at or near sea-level, and in such relation to it that no terrigenous sediments could be laid down on it. In the more littoral zone of Northeast Texas, the Buda is represented

by clays, and the conditions would be even more favorable for the formation of salt basins and the accumulation of gypsum and salt prior to the beginning of Upper Cretaceous sedimentation. There is every reason to believe, therefore, that the gypsum and salt found in connection with the interior domes may have been deposited during the Lower Cretaceous or in the Mid-Cretaceous interval.

While sediments of Jackson age have been found in connection with the salt of the Coastal Domes, in no place has salt been found beneath these deposits. It is found, however, underlying the Neocene beds; what we know, then, is that they are pre-Neocene.

In the Coastal area, so far as is evidenced by the beds at the surface, marine sedimentation closed with the Eocene, and during the Oligocene and Neocene the deposits are largely those of land and fresh water.

That the withdrawal of the sea at the close of the Eocene was accompanied by the deposition of beds of massive gypsum is clearly shown at the southern end of the belt of Gulf Coast Eocene on the Conchos River, in Mexico. Here the Frio clays, which are the uppermost Eocene beds and are probably of Jackson age, form a large portion of the Pomeranes Mountains. They carry in their upper portion heavy beds of massive gypsum, alabaster, and selenite, interbedded with clays. The pre-Oligocene age of the gypsum beds is clearly shown by their relation to the yellow clays of the San Rafael formation lying to the east.

While similar conditions are not positively known to have occurred in East Texas, it is probable that they did, and that the salt and gypsum which occur in connection with the coastal domes was deposited at the time of this emergence and prior to the deposition of the Corrigan sands.

Origin of the Domes

The character and structure of the domes show conclusively that they are the result of orogenic action and that this activity has been manifested at different times and in different degrees.

The interior domes and the Sabine Peninsula were begun by crustal movements at the end of the Upper Cretaceous, and were involved in later movements at the end of the lower Eocene and during the Claiborne or middle Eocene, resulting in total elevations of 2500 ft. (762 m.) or more above their normal horizon.[3]

Similarly, the coastal domes were elevated by orogenic forces acting after the deposition of the Lafayette and prior to that of the Port Hudson clays. The elevations in this case are fully as great as in those of the interior domes, as is proved by drilling. In the case of Damon Mound, the elevation does not appear to have entirely ceased, since the San Bernard

[3] O. B. Hopkins: U. S. G. S. *Bull.* 661 (1917).

River, flowing on its western side, seems to be still cutting its canyon where it crosses it, although to the north and south its banks are low and flat. The movements are most probably the result of isostasy.

The Question of Vulcanicity

According to the writer's point of view, the question of vulcanicity cannot enter into the origin of the materials of which the domes are composed, since, although salt may be formed by volcanic emanations, we have here no need to invoke such a theory of its origin, since a more natural one is probable. Neither is it believed to be the actual dome producer, but rather an accompanying factor or feature of the forces which caused them.

Both salt and anhydrite become liquid at far lower temperatures than any lava, and existing in considerable bodies, as they probably did here, could be readily forced into any opening caused by flexures or faulting of the crust above them more easily than a plug of basalt. Apparently this is what has occurred, and since the term vulcanism is used by Chamberlin and Salisbury[4] "to embrace not only volcanic phenomena in the narrower sense, but all outward forcing of molten material, whether strictly extrusive or merely ascensive," it is thought to cover the phenomena of the intrusive salt, gypsum, and anhydrite stocks in these domes, as fully as if the stocks were basalt or other rock material.

---

[4] T. C. Chamberlin and R. D. Salisbury: "Geology," 2d Ed., 590. New York, Henry Holt & Co., 1906.

INDUSTRIAL SECTION

This department is devoted to material concerning the products or operations of manufacturers, which, in the estimation of the Editor, is of news value to the mining and metallurgical field, but does not come within the scope of the main editorial section of the Bulletin.

Manufacturers are invited to submit to the Editor items descriptive of new equipment or processes, large or significant installations, and similar material of news character. If found available, items thus furnished will be published in this section without charge, subject to such editorial revision and condensation as may be necessary.

In cases where illustrations are required, cuts of the proper size should accompany the text matter.

TRAYLOR JAW AND GYRATORY CRUSHERS

The Traylor Engineering & Manufacturing Co., Allentown, Pa., has taken the lead in the manufacture of jaw crushers of large size, the largest of their jaw crushers having a receiving opening of 66 by 86 in., and weighing 340 tons. In the manufacture of these exceptionally large jaw crushers, certain modifications of the usual design have been necessary, and these are described in Bulletin J-2. For the frames of all crushers, both large and small, the Traylor company now uses steel or semi-steel exclusively, instead of the soft cast iron which has been largely employed for this purpose heretofore. In crushers of the larger size, the frames must be sectionalized, and in addition to the usual bolts for joining these sections, to withstand the enormous stresses to be carried by the frame, tension rods of ample size, which are heated before the nuts are drawn up, are used to give additional strength. The pitman is also made of cast steel and the bearings are water cooled.

The following table shows the relative dimensions of a steam shovel dipper, and the jaw crusher or gyratory crusher required to take the product of this dipper.

Rated Capacity of Dipper in Cubic Yards	Size of Stone, In.	Jaw Crusher, In.	Gyratory, In.
5	48 × 60	60 × 84	54
4	48 × 57	60 × 84	48 or 54
3½	44 × 50	48 × 60	36 or 48
3	40 × 48	48 × 60	36 or 48
2½	36 × 48	36 × 60	30 or 36
2	33 × 45	36 × 60*	24 or 30*
1¾	33 × 45	30 × 48*	21 or 24*
1½	30 × 36	30 × 48*	21 or 24*

*Crusher has a greater capacity than steam shovels equipped with 2, 1¾ or 1½ cu. yd. dipper.

The next table is of interest as indicating the relationship between the size of crushed rock, as determined by the theoretical ring, and as produced by an actual trommel. In order to avoid returning excessive amounts of over-sized material from a screen to a crusher, the holes of the screen must always be larger than the opening of the crusher (Richards recommends 25 per cent. larger), but when a trommel is used, the size of hole must be still further increased because the screening takes place on an inclined surface.

Size of Cube, In.	Size of Ring, In.	Size of Revolving Screen Perforation, In.	Size of Cube, In.	Size of Ring, In.	Size of Revolving Screen Perforation, In.
1/4	3/8	1/2	1 3/4	2 1/2	3
3/8	9/16	3/4	2	2 3/4	3 1/2
1/2	3/4	7/8	2 1/2	3 1/2	4
3/4	1	1 1/4	3	4	5
1	1 1/2	1 7/8	3 1/2	5	6
1 1/4	1 3/4	2 1/4	4	6 1/8	7 1/4
1 1/2	2	2 1/2			

The gyratory crushers manufactured by the Traylor Engineering & Manufacturing Co., and described in Bulletin G-4, do not differ materially in design and general features from those commonly employed heretofore. A few improvements, however, have been made in the design of certain details. The main shaft is of extra large diameter throughout and is not key-seated in any way, making a shaft that is much stronger than found in other crushers of the same size. The hopper completely encircles the top shell, so that it is not necessary to remove it when replacing the spider, shaft, or concaves. The spider is of the two-arm type, in order to make the receiving opening as large as possible. The spider rests clear of the concaves and does not need to be removed when these are replaced. The excentric is designed to present a larger bearing surface than is usually found in gyratory crushers, and special attention has been paid to its lining and lubrication. Bulletin G-4 contains a table showing the size of the machine, size of feed, size of discharge, speed, weight, horsepower required, and capacity.

MANUFACTURERS' NOTICES

The Jeffrey Manufacturing Co., Columbus, Ohio, announces the reopening of its branch office at Cleveland, Ohio, which will be situated at 437 Leader-News Bldg., and will be in charge of Messrs. P. C. Dierdorff and C. B. Reed.

TRADE CATALOGS

(Under this heading will be listed such catalogs or other advertising literature as may be received during the preceding month. Contributors should address their material to. Engineering Societies' Library, 29 West 39th St., New York.)

Aero Pulverizer Co. New York, N. Y. Bulletin 26. Pulverized fuel combustion.

American Steel & Wire Co. New York. Electrical wires and cables. Catalog and Handbook.
American wire rope. Catalog and Handbook.

Central Scientific Co. Chicago, Ill.
Bulletin 15. A new analytical balance.
—— 17. American-made glassware and porcelain for American laboratories. Whatman filter paper.
—— 19. Cenco laboratory rheostats rated for continuous duty.
—— 20. Balances and weights.
—— 36. Matthews gas machine.
—— 45. Cenco-Nelson high-vacuum pumps.
—— 50. A new single-walled drying oven.
—— 61. A new DeKhotinsky drying oven.
—— 70. Cenco Polar water stills.

Delta Star Electric Co. Chicago, Ill.
Bulletin 33. High-tension indoor equipment.

Du Pont de Nemours & Co. Wilmington, Del. Catalog of products, correct to May 15, 1918.

Educational Exhibition Co. Providence, R. I. Catalog E. Graphic record supplies. Mechanical graphs.

Fiske, J. Parker B. Boston, Mass. Cost of a house, a comparison between brick, wood, cement and hollow block construction.
"Fisklock" "Tapestry" brick. Catalog 33-A.
A house of brick for $10,000.
One hundred bungalows.
Tapestry brickwork. Catalog 11-F.
Tapestry brick fireplaces. Catalog 23.
Tapestry brick and tilework for floors and interior walls. Catalog 29.
Through the home of tapestry brick. No. 28.

General Electric Co. Schenectady, N. Y.
Bulletin 41302-A. Polyphase induction motors.
—— 47070. Direct-current standard unit panels 90 in. high, 125 and 250 volts, 2-wire; and 125 to 250 volts, 3-wire, for general power and lighting service.
Class 317 (68202) CR 3100 drum-type controllers for series, etc.

Institute of Makers of Explosives. New York. Use of explosives in making ditches.
Clearing land of rocks for agricultural and other purposes. By J. R. Mattern.
Clearing land of stumps.

Jeffrey Manufacturing Co. Columbus, O.
Bulletin 241. Jeffrey 35-B. Shortwall Mining Machine.
—— 243. Electric Rotary Coal Drills.

Johnson, Henry, Co. Jersey City, N. J. Catalog of Packings.

Larner-Johnson Valve & Engineering Co. Philadelphia, Pa. Bulletin 1. Johnson hydraulic valve.

New England Tank and Tower Company. Everett, Mass. Catalog F. Wood tanks.

Parks, The G. M. Co. Fitchburg, Mass. The Turbo-humidifier, a simple practical device for producing artificial humidity, using an old principle in a new way.

Portland Cement Association. Concrete Construction.

Stone and Webster Engineering Corp. Steam Power Stations, Ed. 2.
Gas Plant Construction, coal- and water-gas generating stations.

Sullivan Machinery Co. Chicago, Ill. Bulletin 73. Sullivan iron-clad coal cutters for room-and-pillar and longwall mining.

Wheeler Condenser & Engineering Co. Carteret, N. J. Bulletin describing the Lillie evaporator for waste waters.

THE MINING AND METALLURGICAL INDEX

July and August, 1918

The Engineering Societies Library is prepared to supply the original, or a copy, translation, or abstract of any paper mentioned in the following index, at the following rates:

Translations, per 1000 words: German or French, $3.50; other languages, $4.50 and upward, by arrangement.

Copies of articles, maps, drawings, etc.

Photoprints, 10 by 14 in., per sheet $0.25

Typewritten, per 1000 words 1.00

Bibliographic searching, abstracting, etc., per hour $1.50

Original article, publisher's price, plus postage. Orders for periodicals will be forwarded to the publishers, and bill will be mailed from the Library.

Address communications relating to the Index to Engineering Societies Library, 29 West 39th Street, New York.

In the following Index, volume numbers are given in heavy-faced figures, page numbers in light-faced figures.

MINERAL RESOURCES

Alaska, Upper Chitina Valley. F. H. Moffit, U. S. Geol. Sur. Dept. of Interior, *Bull.* **675**, 3–82.

Alunite, recently recognized deposits at Sulphur, Humboldt County, Nevada. I. C. Clark, *Engng. & Min. Jnl.* (July 27, 1918) **106**, 159–63.

Antimony in Oklahoma County, Washington. O. P. Jenkins, *Engng. & Min. Jnl.* (Aug. 17, 1918) **106**, 309.

Asbestos and its applications. Amianto i sus aplicaciones. *Bol. Soc. Form. Fabril* (Apr., 1918) **35**, 250–1.

Asbestos deposits of Norway. Nogen norske asbestforekomster. H. Reusch, *Tek. Ukeblad* (July 26, 1918) **65**, 394–5.

Asbestos in South Africa. Amianto na Africa do sul. *Rev. Mineira* (May 15, 1918) **1**, 42–4.

British mineral statistics. *Engr.* [London] (July 5, 1918), **76**, 12–3.

Cadmium. C. E. Siebenthal, U. S. Geol. Sur., Dept. of Interior, *Mineral Resources of the U. S.* Pt. 1, No. 5, 49–53.

Caliche beds found to be small in Southeastern California. *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 199.

Canada's coal resources, rational development. *Jnl*, Engng. Inst. of Can. (May, 1918) **1**, 10–6.

Canadian, Hints on prospecting for a few, minerals. W. Malcolm, *Monthly Bull.* Can. Min. Inst. (Aug., 1918) 692–704.

Chrome ore in California. *Iron Age* (July 25, 1918) **102**, 211.

Chromite, speeding up, production. *Engng. & Min. Jnl.* (July 13, 1918) **106**, 53.

Clay, report on resources of Southern Saskatchewan. N. B. Davis, Dept. of Mines, Canada. No. 468 (1918) 1–93.

Coal, Blairmore area, Alberta. *Can. Min. Jnl.* (July 1, 1918) **39**, 219.

Copper deposits of the Blue Ridge Mountains. M. Haney, *Engng. & Min. Jnl.* (Aug. 10, 1918) **106**, 248.

Corundum, Report on certain minerals used in the arts and industries. P. A. Wagner, *South Afr. Jnl. Ind.* (May, 1918) **1**, 776–97.

Corundum deposits of South America. P. A. Wagner, *South Afr. Min. Jnl.* (May 25, 1918) **27**, 76; II (June 1, 1918) **27**, 105; III (June 8, 1918) **27**, 137; IV (June 22, 1918) **27**, 183–6. Serial.

Georgia, deposits of Claiborne and Jackson age in. U. S. Geol. Sur. *Professional paper.* 120–C, 41–81.

Gems and precious stones in 1916. W. T. Schaller, U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of the U. S.* Pt. 2, No. 34, 887–99.

Glass sands of Pennsylvania. C. R. Fettke, *Science* (July 26, 1918) **48**, 98–100.

Gold, status of. Editorial. *Min. & Sci. Pr.* (Aug. 10, 1918) **117**, 174–5.

Gold, market value of. W. de L. Benedict, *Min. & Sci. Pr.* (Aug. 17, 1918) **117**, 209–10. Letter.

Gold is needed. *Canad. Min. Jnl.* (July 1, 1918) **39**, 218–9. Editorial.

Gold and silver in 1916. H. D. McCaskey and J. P. Dunlop, U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of U. S.* Pt. 1, No. 21 (1918), 679–721.

GOLD conference, American. C. De Kalb, *Min. & Sci. Pr.* (Aug. 24, 1918) **117**, 243–4.

GOLD, vital need. J. Clausen, *Engng. & Min. Jnl.* (Aug. 24, 1918) **106**, 348–9. Abstract from an address to the Am. Gold Conference.

GOLD production must be kept up. *Min. Cong. Jnl.* (Aug.. 1918) **4**, 294–5.

GOLD production, crisis, Congress must act. B. L. Thane. *Engng. & Min. Jnl.* (July 27, 1918) **106**, 164–6.

GOLD production, importance of, L. Phillips, *Min. & Sci. Pr.* (Aug. 3, 1918) **117**, 158–60.

GOLD, menace to, mining. M. T. Chestnut, *Min. & Sci. Pr.* (Aug. 10, 1918) **117**, 178–9. Letter.

GOLD, menace to, mining. J. A. Burgess, *Min. & Sci. Pr.* (Aug.. 10, 1918) **117**, 177–8. Letter (July 27, 1918) 122–5.

GOLD mining. crisis. *Alas. Northw. Min. Jnl.* (Aug., 1918) **12**, 26–7.

GOLD mining, crisis. *Min. Cong. Jnl.* (July, 1918) **4**, 242–3.

GOLD mining, status of. A. Burch, *Min. & Sci. Pr.* (Aug. 17, 1918) **117**, 209. Letter (July 27, 1918) **117**, 108. Editorial.

GOLD situation. G. E. Collins sees impending crisis in, *Min. Cong. Jnl.* (Aug., 1918) **4**, 306–7.

GOLD situation. *Min. Cong. Jnl.* (Aug., 1918) **4**, 287. Editorial.

GRAPHITE in 1917. H. G. Ferguson, U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of the U. S.* Pt. 2, No. 8, 97–119.

GRAPHITE industry. *Min. Jnl.* (June 22, 1918) **121**, 369–70.

GYPSUM in 1917. R. Stone, U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of U. S.* Pt. 2, No. 7, 85–95.

INDIAN lands may be open for leasing, mineral deposits on. *Min. & Oil Bull.* (July, 1918) **4**, 321–2.

INDIAN lands, leasing mineral deposits on. *Min. & Sci. Pr.* (June 29, 1918) **116**, 878.

INDIAN reservations, Senate passes bill to authorise mining on. *Engng. & Min. Jnl.* (Aug. 3, 1918) **106**, 210.

IRON, report on the sources and production of, and other metalliferous ores used in the iron and steel industry. Dept of Sci. & Ind. Research. Advisory Council. (1918) 1–180.

IRON, British and colonial, ore supplies. *Engng.* (June 28, 1918) **105**, 728–9.

IRON formation on Belcher Islands, Hudson Bay, with special references to its origin and its associated algal limestones. E. S. Moore, *Jnl. Geol.* (July–Aug., 1918) **26**, 412–38.

IRON deposits of Huacravilca. Yacimiento de fierro de Huacravilca. E. I. Duenas, *Bol.* Cuerpo Ingen. de Minas, Peru. No. 87, 7–80.

IRON resources of Canada. *Engng.* (June 21, 1918) **105**, 685–7.

IRONSTONES, jurassic, of the United Kingdom economically considered. *Iron & Steel Inst.* Advance copy, No. 4, 1–46.

LIMONITE deposits in Porto Rico. C. R. Fettke and B. Hubbard, *Iron Tr. Rev.* (July 25, 1918) **63**, 210–1. Abstract, A. I. M. E. *Bull.* 135.

MANGANESE deposits in White Pine County, Nevada. *Engng. & Min. Jnl.* (Aug. 17, 1918) **106**, 308.

MANGANESE deposits in Madison County, Montana. U. S. Geol. Sur. Dept. of Interior *Bull.* 690-F, 131–43.

MANGANESE and manganiferous ores in 1916. U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of the U. S.* Pt. 1, No. 23, 731–56.

MANGANESE ore shipments. *Shipping* (July 13, 1918) **4**, 37.

MANGANESE mines in Italy. G. Castelli, *Rassegna Mineraria* (Apr., 1918) **24**, 64–6.

MANGANESE for America. *Iron & Steel Tr. Jnl.* (Aug. 3, 1918) 119.

MAGNESITE in 1917. U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of the U. S.* Pt. 2, No. 5, 63–79.

MINERAL industry after the war. J. F. Brown, Canad. Min. Inst. *Bull.* (July, 1918) 631–5. Letter.

MOLYBDENUM-Ilsemannite. H. F. Yancey. *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 186–90.

MOLYBDENUM, tungsten and bismuth. *Indust. Austral.* (May 16, 1918) **59**, 495–6; (June 6, 1918) **59**, 589; (June 13, 1918) **59**, 623–4; (June 20, 1918) **59**, 655–6; (June 27, 1918) **59**, 688–9; (July 4, 1918) **60**, 29–30. Serial.

GEOLOGY and ore deposits of Ely, Nevada. A. C. Spencer and C. H. Clapp, *Econ. Geol.* (July, 1918) **8**, 400–9. Review.

NEW YORK. Quarry materials of, granite, gneiss, and marble. *New York State Museum Bull.* 181, **2**, 7–212.

NEW YORK State, Mining and quarry industry. *New York State Museum Bull.* **190**, **2**, 7–92.

NICKEL mining. Mineria del niquel. *Rev. Minera* (July 1, 1918) **69**, 321.

NITRATE deposits, Chilean. Irvin, Donald J. Letter. *Min. & Sci. Pr.* (July 27, 1918) **117**, 109–10.

NITRATE deposits in Amargosa Sink reported on by geological survey. *Engng. & Min. Jnl.* (Aug. 10, 1918) **106**, 264.

PERU, Carboniferous deposits in the district of Llapo. Yacimientos carboniferos del distrito de Llapo. *Bol.* Cuerpo Ingen. de Minas, Peru. No. 89 (1918) 9–24.

PERU, geological observations between Lima and Chanchamayo. Observaciones geologicas efectuadas desde Lima hasta Chanchamayo. *Inform. Soc. Ing. Peru* (June, 1918) **20**, 235–49.

PERU'S coal resources. *Iron & Coal Tr. Rev.* (July 26, 1918) **97**, 87.

PHILIPPINES, metal mining. *Min. Jnl.* (July 13, 1918) **122**, 417.

PHOSPHATE rock in 1917. *Am. Fertilizer* (July 20, 1918) **49**, 68–86.

PLATINUM find near Fifield. *Chem. Engng. & Min. Rev.* (Mar. 5, 1918) **10**, 185.

PLATINUM riches of Russia. *Russia* (June, 1918) **3**, 24–9.

PLATINUM and allied metals. J. M. Hill. U. S. Geol. Sur. Dept. of Interior. *Mineral Resources of the U. S.* Pt. 1, No. 2, 11–21.

POTASH mines. Minas de sales potásicas. *Rev. Minera* (June 16, 1918) **69**, 293–9.

POTASH, sources of. *Engng.* (July 19, 1918) **106**, 68–9.

POTASH, prospects of founding, industry in this country. K. M. Chance, *Jnl.* Soc. Chem. Ind. (July 31, 1918) **37**, 222–30. Also in *Iron & Coal Tr. Rev.* (July 26, 1918) **97**, 85–7.

PYRITE, State geologist reports on, industry in Georgia. *Commercial Fert.* (July, 1918) **16**, 48.

PYRITE deposits of Georgia. *Engng. & Min. Jnl.* (Aug. 3, 1918) **106**, 213.

PYRITES. *Canad. Min. Jnl.* (Aug. 1, 1918) **39**, 268–9.

QUEENSLAND State mining enterprises. *Queensland Govt. Min. Jnl.* (June 15, 1918) **19**, 262-

QUEENSLAND, Mining industry. *Queensland Govt. Min. Jnl.* (July 15, 1918) **19**, 252–6.

MINING GEOLOGY AND MINING PRACTICE

(See also Coal and Coke)

Pulverized Coal Equipment

New York, N. Y., 50 Church St.; Chicago, Ill., McCormick Bldg.; Parsons, Kan., First Nat. Bank Bldg.

ORE-DRESSING, AND PREPARATION OF COAL

Copper, treatment of, ores. W. H. Hyatt, British Pat. 116181. *Illus. Off. Jnl.* (July 31, 1918) 1512.

Crushers with vibrating jaws. A. Schar, British Pat. 115424. *Illus. Off. Jnl.* (July 3, 1918) 1227.

Crushing and cyaniding in a West African mill. P. T. Bruhl, *Engng. & Min. Jnl.* (July 13, 1918) **106**, 54–7.

Efficiency of ball-mills. *Engng. & Min. Jnl.* (Aug. 17, 1918) **106**, 319. Editorial.

Filter adjustments at Packard Mill at Rochester, Nevada. *Engng. & Min. Jnl.* (Aug. 3, 1918) **106**, 207–9.

Flotation of silver ores in Canada. Flutuaçao dos minerais de prata no Canada. *Rev. Mineira* (May, 1918) **1**, 39–41.

Flotation, notes. R. W. Diamond, Canad. Min. Inst. *Bull.* (July, 1918) 622–6.

Flotation, cascade method of froth. A. W. Fahrenwald, *Min. & Sci. Pr.* (July 20, 1918) **117**, 87–8.

Flotation apparatus, its design and operation. A. W. Fahrenwald, *Chem. & Met. Engng.* (Aug. 1, 1918) **19**, 129–34.

Flotation, Flottaison des minerais. *Génie Civil* (July 13, 1918) **73**, 32–4.

Flotation machine, Ruth. A. J. Hoskin, *Min. & Sci. Pr.* (July 27, 1918) **117**, 119–21.

Flotation, effect of addition agents in. M. H. Thornberry, *Bull.* Sch. Mines & Met. (Nov., 1917) **4**, 1–48.

Flotation, use of oil in, concentration. O. C. Ralston, *Chem. Engng. & Min. Rev.* (Mar. 5, 1918) **10**, 173.

Flotation, molecular physics of ore. W. H. Coghill, *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 168. Letter.

Flotation apparatus. F. B. Flinn, *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 168–9.

Gold, charcoal precipitation of, in cyanide solutions. *Chem. Engng. & Min. Rev.* (July 5, 1918) **10**, 309–10.

Gold separators. B. Tuggle, Australian Pat. 4450. *Queensland Govt. Min. Jnl.* (May 15, 1918) **19**, 235.

Grinding, crushing, etc. A. D. Furse and A. J. Neil, British Pat. 115542. *Illus. Off. Jnl.* (July 10, 1918) 1273.

Grinding machine. Lets Manufacturing Company, Canad. Pat. 183647. *Canad. Pat. Off. Rec.* (Apr., 1918) 1146.

Grinding of ore in ball-mills. D. H. Fairchild, *Engng. & Min. Jnl.* (Aug. 17, 1918) **106**, 311.

Macquisten tube flotation machine. C. T. Rice, *Engng. & Min. Jnl.* (July 27, 1918) **106**, 163.

Magnetic separators. Fraser & Chalmers, British Pat. 116228. *Illus. Off. Jnl.* (July 31, 1918) 1529.

Metals and metal industries of Latin America. P. F. Martin, *Metal Ind.* (June 28, 1918) **12**, 485–7. Serial.

Mineral concentrator. C. Michaelsen and W. P. Michaelson, U. S. Pat. 1269198. *Off. Gaz.* (June 11, 1918) **251**, 335.

Ore-separating device. R. W. Haddock, U. S. Pat. 1269704. *Off. Gaz.* (June 18, 1918) **251**, 507.

Ore-separator. F. Gottfried, U. S. Pat. 1272125. *Off. Gaz.* (July 9, 1918) **252**, 419.

Ore-separator. R. E. Nelson, U. S. Pat. 1272301. *Off. Gaz.* (July 9, 1918) **252**, 468.

Oxygen in precipitating gold from cyanide solutions. T. B. Crowe, *Min. & Sci. Pr.* (Aug. 24, 1918) **117**, 251–2. Abstract of paper in A. I. M. E. *Bull.* No. 140.

Process of, and apparatus for concentrating ores. C. J. B. Armstrong, U. S. Pat. 1269150. *Off. Gaz.* (June 11, 1918) **251**, 322.

Process of concentrating ores. J. M. Callow, U. S. Pat. 1269157. *Off. Gaz.* (June 11, 1918) **251**, 324.

Process for treating ores. H. E. Cleaves and F. W. Horton, U. S. Pat. 1268323. *Off. Gaz.* (June 4, 1918) **251**, 72.

Process for concentrating ores. K. R. Cransley, British Pat. 115199. *Illus. Off. Jnl.* (June 26, 1918) 1150.

Process for concentrating ores. B. H. Dosenbach, U. S. Pat. 1268940. *Off. Gaz.* (June 11, 1918) **251**, 264.

Process for ore enriching. K. Sundberg, Canad. Pat. 183479. *Canad. Pat. Off. Rec.* (Apr., 1918) 1063.

Process for obtaining gold and silver from their ores. A. A. Lockwood, New Zeal. Pat. 40059. *New Zeal. Pat. Off. Jnl.* (July 11, 1918) **7**, 291.

Process of gold recovery, sodium sulphide. F. Wartenweiler, Instn. Min. & Met. *Bull.* **166** (July 25, 1918) 1–13.

Pulverizing apparatus. D. Marks and L. S. Atkinson, Canad. Pat. 184049. *Canad. Pat. Off. Rec.* (Apr., 1918) 1338.

Purification of precipitates. D. Burns, U. S. Pat. 1272375. *Off. Gaz.* (July 16, 1918) **252**, 516.

Pyrite briquettes, process for making. Procédé pour la fabrication de briquettes de pyrites. M. Pierron, French Pat. 486838. *Bull.* Off. Propriété Indust. Paris (Mar. 7, 1918) No. 1779, 27.

Roaster, new American spirlet. F. J. Harlow, *Engng. & Min. Jnl.* (Aug. 17, 1918) **106**, 293–9.

Separating, method and apparatus for, ores and the like. A. B. Emery, U. S. Pat. 1272643. *Off. Gaz.* (July 16, 1918) **252**, 591.

Separation of ores and the like. A. B. Emery, U. S. Pat. 1272642. *Off. Gaz.* (July 16, 1918) **252**, 591.

Slate, new method of separating from coal. H. M. Chance, *Jnl.* Engrs. Club, Phila. (Aug., 1918) **35**, 369–78. Presented at Engrs. Club.

Spiral, adjustable separator. J. H. Becker, U. S. Pat. 1270365. *Off. Gaz.* (June 25, 1918) **251**, 711.

Sulphide ore concentration. J. Hebbard, Australian Pat. 2743. *Queensland Govt. Min. Jnl.* (May 15, 1918) **19**, 235.

Tin concentrating plants in Cornwall. *Engng. & Min. Jnl.* (Aug. 3, 1918) **106**, 214–5. Photographs.

Tin, Neil jig tests for, dredging. L. H. Eddy, *Engng. & Min. Jnl.* (July 13, 1918) **106**, 78.

Tin-wolfram-lead ore, concentrating. *Min. & Sci. Pr.* (Aug. 3, 1918) **117**, 162.

Titanic-oxid concentrate and method for obtaining the same. A. J. Rossi, U. S. Pat. 1272855. *Off. Gaz.* (July 16, 1918) **252**, 652.

Treating ores. F. Rigaud, British Pat. 116263. *Illus. Off. Jnl.* (July 31, 1918) 1541.

Treating ores. J. S. Ross, British Pat. 115088. *Illus. Off. Jnl.* (June 19, 1918) 1109.

Treatment of ores. G. Vogelsang, Australian Pat. 422. *Queensland Govt. Min. Jnl.* (May 15, 1918) **19**, 235.

Washing down waste or culm banks. E. B. Wilson, *Coal Ind.* (July, 1918) 267–8.

COAL AND COKE

(See also Mineral Resources, Mining Geology and Mining Practice, and Ore-dressing and Preparation of Coal)

ANTHRACITE, Eastern middle field. E. B. Wilson, *Coal Ind.* (Aug., 1918) Pt. III, 292–4. Serial.

ANTHRACITE, Utilisation of fine grades. *Power* (July 23, 1918) **48**, 143–6.

ANTHRACITE, Northern coal field. E. B. Wilson, *Coal Ind.* (July, 1918) **1**, 255–8.

BLUE DIAMOND coal company. W. S. Hutchison, *Mine and Quarry* (July, 1918) **10**, 1058–64.

BRITISH COLUMBIA, Coal mining in. R. Dunn, *Coal Age* (July 13, 1918) **14**, 55–7.

BYPRODUCT coke oven pressure regulation. C. H. Smoot, *Furnace and Steel Plant* (Aug. 6, 1918) 331–5. Serial.

BYPRODUCT coking practice. Some characteristics of American coals. F. W. Sperr, *Jnl.* Franklin Inst. (Aug., 1918) **186**, 133–64.

BYPRODUCTS, Wastage of coke. F. Maccoy, *Engng. & Min. Jnl.* (Aug. 10, 1918) **106**, 254–5.

BYPRODUCTS, Recovery of, in coke manufacture. M. Meredith, *Coal Age* (July 13, 1918) **14**, 60–2.

BYPRODUCTS, Coke-oven, in 1917. *Coll. Guard.* (July 12, 1918) **116**, 69–70.

CANADA, Fuels of Western. J. White, *Jnl.* Engng. Inst. Canad. (Aug., 1918) **1**, 155–62.

CANADIAN FUELS, Analyses of. Pt. I. E. Stansfield and J. H. Nicolls, Dept. of Mines, Canada, *Bull.* 22 (1918) 1–28. Pt. II, *Bull.* 23, (1918) 1–25. Pt. III, *Bull.* 24, 1–15. Manitoba and Saskatchewan. Pt. IV, *Bull.* 25, 1–68. Pt. V, *Bull.* 26, 1–24, British Columbia and Yukon Territory.

CLEAN coal, Emergency and. G. H. Elmore, *Coal Age* (July 20, 1918) **14**, 122–6.

COAL MINING and man power. F. A. Pocock, *Coal Age* (Aug. 22, 1918) **14**, 350–1.

COKE, Development of the, industry. F. C. Miller, *Coal Ind.* (Aug., 1918) **1**, 302–4.

COKE industry, An innovation in the. J. L. Gans, *Coal Age* (Aug. 8, 1918) **14**, 256–7.

COKING, British Pat. 114971. J. A. Yeadon, *Illus. Offi. Jnl.* (June 19, 1918) 1054.

COKING. Apparatus for converting beehive ovens into byproduct coke-ovens. U. S. Pat. 1269895. B. Zwillinger, *Off. Gaz.* (June 18, 1918) **251**, 561.

CONSERVATION in use of coal. *Jnl.* Engrs. Club Phila. (Aug., 1918) **35**, 390–9.

CONSERVATION of fuel. H. James, *Power House* (May, 1918) **11**, 127–9.

CONTROL Scheme. Coal mines, II. Scope. *Iron & Coal Trade Rev.* (July 19, 1918) **97**, 68.

DETERMINATION of volatile matter and ash in coal. N. H. Humphreys, *Gas World* (June 29, 1918) **68**, 436–7.

ECONOMICAL use of fuel. *Jnl.* A. S. M. E. (July, 1918) **40**, 603–60. Papers read at Worcester meeting.

EVOLUTION of coal, Wonderful, and its prospects. W. Leighton, *Gas Jnl.* (June 11, 1918) **142**, 497–8. Serial.

FATALITIES, Monthly statement of coal-mine, in the United States. A. H. Fay (April, 1918) Dept. of Interior, Bureau of Mines. 5–23.

FLOW OF AIR through small coal and other broken material. J. T. Storrow, *Iron and Coal Tr. Rev.* (June 14, 1918) **96**, 672.

FUEL economy in the operation of hand-fired-power plants. *Contr. Rec.* (July 3, 1918) **32**, 527–31.

FUEL RESEARCH, Report on their scheme of research and on the establishment of a station. *Dept. of. Sci. & Ind. Research*, London (1918) 3–10.

HANDLING, Problems of coal. W. B. Woodhouse, *Electn.* (June 28, 1918) **81**, 162–5.

IMPURITIES, Economic effect of, in coal. *Nat. Engr.* (Aug., 1918) **22**, 391–2. W. N. Polakov.

INCREASING coal production, A suggestion for. N. D. Levin, *Coal Age* (July 20, 1918) **14**, 104–5.

INDIA, Commercial development of coal in. S. H. Godfrey, *Indian Engng.* (May 18, 1918) **63**, 279–80.

LOW-TEMPERATURE carbonisation of coal, Some aspects of the. E. C. Evans, *Iron & Coal Tr. Rev.* (July 26, 1918) **97**, 88–9.

LOW-TEMPERATURE carbonization of fuels. *Jnl. Engng. Inst. Canad.* (May, 1918) **1**, 19–23.

LUBRICATION, Coal production and. R. Trautschold, *Coal Age* (July 25, 1918) **14**, 175–6.

MARYLAND coal field, Heart of the. G. L. Yaste, *Coal Ind.* (Aug., 1918) **1**, 283–4.

MECHANICAL handling of coal and coke. Manutention mécanique des charbons et des cokes. *Génie Civil* (July 6, 1918) 10–2.

MICRO-CHEMICAL examination of coal. *Coll. Guard.* (June 14, 1918) **115**, 1195–6.

MICRO-CHEMICAL examination of coal in relation to its utilisation. J. Lomax, *Gas World* (July 6, 1918) **69**, 82–3.

NATIONAL coal supply and its utilisation. C. G. Gilbert and J. E. Pogue, *Gas Age* (Aug. 1, 1918) **42**, 97–100. Serial. Also (Aug. 15, 1918) **42**, 154–6.

ORIGIN and composition of coal, Some notes on. G. Knox, *Proc.* South Wales Inst. of Engrs. (July, 1918) **34**, 83–99.

OXYGEN, Diffusion of, through stored coal. S. H. Katz, Dept. of Interior, Bureau of Mines. *Tech. paper* 170. (1918) 3–47.

PRESIDENT Wilson's proclamation to coal miners. *Ry. Rev.* (Aug. 17, 1918) **63**, 254–5.

PULVERIZED Coal, Use of. H. R. Collins, *Engng. & Min. Jnl.* (Aug. 17, 1918) **106**, 305–7. (Reprint from A. I. M. E. *Bull.* 136, 955.)

QUEENSLAND. Coal near Wondai. *Queensland Govt. Min. Jnl.* (May 15, 1918) **19**, 207.

SPAIN. Coal mining developments. *Coll. Guard.* (July 5, 1918) **116**, 30.

SQUANDERING the Nation's heritage. R. H. Fernald, *Iron Tr. Rev.* (Aug. 8, 1918) **63**, 323–7. Abstract of paper presented at Cleveland Engng. Soc. Reckless expenditure of our coal reserve.

STORAGE of bituminous coal. H. H. Stoek, *Power Plant Engng.* (Aug. 1, 1918) **22**, 614–6.

STORAGE and handling of gas coal. H. H. Stoek. *Gas Age* (Aug. 15, 1918) **62**, 145–9.

STORAGE of bituminous coal with reference to its liability to spontaneous combustion in storage. J. H. Anderson, *Elect. Rev.* (July 26, 1918) **83**, 78–9.

STOWING coal in a small plant. *Elect. World* (July 27, 1918) **72**, 148–9.

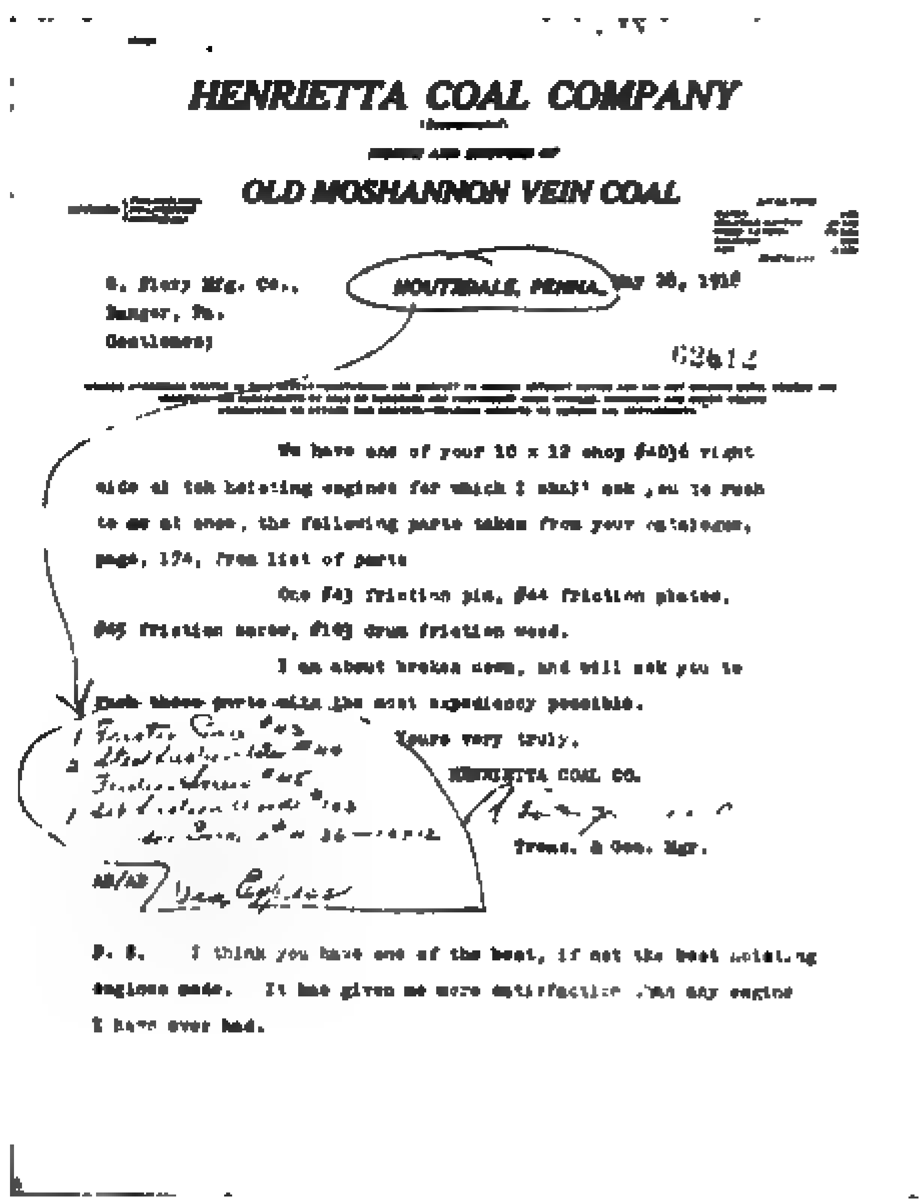
STORING coal successfully. *Power* (Aug. 13, 1918) **48**, 248–9.

STORING small coal. M. Meredith, *Coal Age* (Aug. 8, 1918) **14**, 255.

STORING soft coal, Detailed facts about. H. H. Stoek, *Black Diamond* (July 29, 1918) **61**, 48, *et seq.*

PETROLEUM AND GAS

METALLURGY OF IRON AND STEEL



HENRIETTA COAL COMPANY

OLD MOSHANNON VEIN COAL

S. Flory Mfg. Co.,
Bangor, Pa.
Gentlemen;

HOUTZDALE, PENNA. May 26, 1916

62612

We have one of your 10 x 12 shop #4036 right side at ten hoisting engines for which I shall ask you to rush to me at once, the following parts taken from your catalogue, page, 174, from list of parts

One #43 friction pin, #44 friction plates, #45 friction screw, #103 drum friction wood.

I am about broken down, and will ask you to rush these parts with the most expediency possible.

Yours very truly,

HENRIETTA COAL CO.

Treas. & Gen. Mgr.

P. S. I think you have one of the best, if not the best hoisting engines made. It has given me more satisfaction than any engine I have ever had.

FLORY TWO SPEED

Two Patent Band Frictions. Loaded trip, 20,000 lb., 250′ per min.
Frictions operated by air. Empty trip, 7,000 lb., 500′ per min.
Herringbone Gears. Dial Indicator. On plane of 26 deg.

S. FLORY MFG. CO.

BANGOR, PA.

New York Office: 35 Liberty St.

EUTECTIC alloys, III. C. W. Nash, *Chem. Engng. & Min. Rev.* (Mar. 5, 1918) **10**, 161–6.

EXPANSION of metals by heat. J. Roger, *Westn. Engng.* (Aug., 1918) **9**, 316. *Min. & Sci. Press* (July 27, 1918) **117**, 112.

FAHY Permeameter, Experimental study of. C. W. Burrows and R. L. Sanford, *Electn.* (July 5, 1918) **81**, 202–3.

FERROCHROME. R. M. Keeney, *Colo. Sch. Mines Mag.* (Aug., 1918) **8**, 143–7.

FERROMANGANESE, Making, in California. *Min. & Sci. Pr.* (July 20, 1918) **117**, 89.

FERROMANGANESE, Making, in California. *Westn. Engng.* (Aug., 1918) **9**, 303.

FERROMANGANESE in steel making, Liquid. *Iron Age* (July 25, 1918) **102**, 208–9.

FERROMANGANESE, oscillating furnace for the melting of. Four oscillant pour la fusion de ferro-manganese et autres alliages ou métaux. Société anonyme acideries réunies de Burbach-Eich-Dudelauge. French Pat. 486–785. *Bull.* Off. Propriété Indust. Paris (Mar. 7, 1918). No. 1779, 27.

FERROMANGANESE, Supplies of. *Iron Age* (July 25, 1918) **102**, 212.

FERROMANGANESE, manufacture of, in Bilbao. Fabrication del ferromanganese en Bilbao. *Rev. Minera* (July 24, 1918) **69**, 365.

FERROPHOSPHORUS, British Pat. 111385. J. J. Gray, *Illus. Off. Jnl.* (Jan. 23, 1918) 3363.

FERROSILICONS not attacked by acids. Les ferro-siliciums inattaquables aux acides. C. Matignon, *Compt. Rend. Acad. d. Sci.* (May 21, 1918) **166**, 815–21.

FIRE-BRICKS, Effect of load on refractoriness of, etc. J. W. Mellor and W. Emery, *Iron & Coal Tr. Rev.* (June 14, 1918) **96**, 665. Report of research committee.

FORGINGS, Question of quenching oils for. L. H. Mac Laughlin (July, 1918) *Am. Drop Forger* 273–7.

FUEL economy in blast furnaces. T. C. Hutchinson (1918) *Iron & Steel Inst.* Advance copy 5, 1–15.

FURNACE, Ore smelting and refining. Canad. Pat. 183314. O. Martin, *Canad. Pat. Office Rec.* 976.

FURNACE, Smelting. U. S. Pat. 1269974. A. M. Stevenson, *Off. Gaz.* (June 18, 1918) **251**, 580.

FURNACE, Surface combustion. Fours à radiation superficielle. M. P. Begrier, *Rec. Metall.* (July, 1918) **15**, 391–8.

FURNACE, Metallurgical. Canad. Pat. 183485. O. Wedge, *Canad. Pat. Off. Rec.* (Apr., 1918) 1065.

FURNACES and converters. British Pat. 115323. A. Rollason, *Illus. Off. Gaz.* (July 3, 1918) 1196.

FUSION welding fallacies. S. W. Miller, *Machy.*, N. Y. (Aug., 1918) **24**, 1082–4. (Sept., 1918) **25**, 12–3.

GALVANIZING sheets, Modern practice in. C. F. Poppleton, *Iron Age* (Aug. 22, 1918) **102**, 433–6. Serial.

GAS furnace for melting metals and alloys. Four à gaz pour la fusion des métaux et des alliages en creusets. French Pat. 486602. *Bull.* Off. Propriété Industrielle (Feb. 14, 1918) No. 1776, 14.

GEARS and their treatment, Steels for. G. A. Richardson, *Iron & Coal Tr. Rev.* (Aug. 2, 1918) **97**, 116.

HARDENING and tempering, Some practical hints on. H. H. Jones, *Model Engr.* (June 20, 1918) **38**, 363–6. Serial.

HARDNESS of metals, Notes on testing. J. W. Craggs, *Sci. Am. Sup.* (Aug. 10, 1918) **86**, 94–5.

HARDNESS of metals, Testing, by the Boyelle-Morin apparatus. C. J. B. Cooke, *Jnl. Inst. Mech. Engrs.* (May, 1918) **5**, 331–3.

HEAT treatment, System of. *Page's Engng. Wkly.* (June 28, 1918) **32**, 309.

HEAT treatment and the hardening and tempering of steel. C. A. Edwards, *Canad. Machy.* (July 25, 1918) **20**, 82–6.

HEAT treatment, Effect of mass on. E. F. Law, *Iron & Steel Inst.* (1918). Advance copy 16, 1–15. Abstract, *Mech. World* (May 17, 1918) **63**, 238.

HEAT TREATED bars, Change in dimension of. *Iron Age* (Aug. 1, 1918) **102**, 312–3.

HEAT treatment, Commercial steels and their. J. B. Hoblyn, *Aeronautics* (June 5, 1918) **14**, 489–98.

HEATING furnace for metal bars. Canad. Pat. 183326. C. Fassinger, *Canad. Pat. Off. Rec.* (Apr., 1918) 981.

HOLLOW FORGINGS, Development of flaws in. A. S. Hesse, *Am. Machinist* (July 25, 1918) **49**, 153–4.

INCLINED mold is a fallacy, Why the. R. R. Clarke, *Foundry* (Aug., 1918) **46**, 351–2.

INCLUSIONS in steel, Importance of the non-metallic. *Nature* (June 27, 1918) **101**, 334–5.

INCLUSIONS, Non-metallic: their constitution and occurrence in steel. A. McCance, *Iron & Steel Inst.* Advance copy, 14, 1–48.

INCLUSIONS in steel and ferrite lines, Note on. J. E. Stead, *Iron & Steel Inst.* Advance copy 13. 1–6.

INDIA, Technical aspects of the establishment of the heavy steel industry in, with results of some researches connected therewith. A. McWilliam, *Iron & Steel Inst.* (1918). Advance copy 10, 1–20.

INGOTS, Dish-cast. J. A. Holden, *Foundry Tr. Jnl.* (June 20, 1918) **20**, 319.

INGOTS, during cooling, On the distribution of temperature in steel. Seso Saito, *Jour.* Soc. Mech. Engrs. Tokyo, Japan (May, 1918) **21**, 15–30.

INGOT mould. O. A. Fogerty and C. Hodgson, Canad. Pat. 184050. *Canad. Pat. Of. Rec.* (Apr., 1918) 1339.

INGOT manipulator for rolling mills. *Iron & Coal Tr. Rev.* (July 12, 1918) **97**, 42.

IRON, carbon, and phosphorus. J. E. Stead. *Iron & Steel Inst.* (1918). Advance copy 19, 1–24.

JAPANESE steel industry, Future of. J. P. Suzuki, *Iron Tr. Rev.* (Aug. 15, 1918) **63**, 389–90.

LABORATORIES. Laboratoires dans les établissements sidérurgiques. M. Wencelius, *Bull.* Soc. Ingen. Civ. France (May 31, 1918) 76–8.

MACROSTRUCTURE of steel examined by means of the copper test of Stead-Le-Chatelier. La Macrostructure de l'acier. A. P. Bernard, *Revue de Métall.* (May–June) **15**, 273–80.

MAGNETIC ironsand etc., Iron and steel manufacture from. New Zealand Pat. 390322. W. R. Heskett, N. Z. Pat. Off. *Jnl.* (June 27, 1918) **7**, 262.

MAGNETIC purposes, Preparation of pure alloys for. T. D. Yensen, *Trans.* Am. Electrochem. Soc. (1918) **32**, 165–84.

MAGNETITE, Smelting of. Canad. Min. Inst. *Bull.* (July, 1918) 627–8.

MALLEABLE cast iron. *Page's Engng. Wkly.* (June 28, 1918) **32**, 304–6.

MALLEABLE iron castings, Manufacturing heavy. A. W. Lorenz, *Foundry* (Aug., 1918) **46**, 350–1.

METALLURGY OF NON-FERROUS METALS

ELECTRIC furnace. U. S. Pat. 1271760. C. A. Pfanstiehl, *Off. Gaz.* (July 9, 1918) **252**, 314.

ELECTRIC furnace. U. S. Pat. 1272077. W. E. Moore, *Off. Gaz.* (July 9, 1918) **252**, 406.

ELECTRIC furnace. U. S. Pat. 1273920. C. A. Pfanstiehl, *Off. Gaz.* (July 30, 1918) **252**, 1003.

ELECTRIC furnaces. British Pat. 115248. V. C. Faulkner, *Illus. Off. Gaz.* (June 26, 1918) 1166.

ELECTRIC MELTING furnaces, Development of. H. W. Gillett and A. E. Rhoads, *Metal Ind.* N. Y. (Aug., 1918) **16**, 355–8.

ELECTROLYSIS. British Pat. 116139. G. T. Holloway, *Illus. Off. Jnl.* (July 24, 1918) 1495.

ELECTROLYTIC copper refinery, construction and operation of. J. E. McAllister, *Engng. & Min. Jnl.* (Aug. 24, 1918) **106**, 337–41.

ELECTRO-METALLURGICAL industry, Evolution of the. *Metal Ind.* (June 14, 1918) **12**, 459–60.

EXPANSION of metals by heat. J. Roger, *Westn. Engng.* (Aug., 1918) **9**, 316; *Min. & Sci. Pr.* (July 27, 1918) **117**, 112.

FUME, New-treatment plant at Anaconda. D. M. Brown, *Min. & Sci. Pr.* (June 29, 1918) **116**, 895–7.

FURNACE, Smelting and refining. O. J. T. G. R. Martin, U. S. Pat. 1271051. *Off. Gaz.* (July 2, 1918) **252**, 85.

FURNACE, Ore smelting and refining. Canad. Pat. 183314. *Canad. Pat. Off. Rec.* (Apr., 1918) 976.

GERMAN-owned metal firms. Statement regarding seizure of L. Vogelstein & Co., Inc. and Beer, Sondheimer & Co., Inc. of New York City. *Steel & Met. Dig.* (Aug., 1918) **8**, 475–7.

GERMAN trade ended. *Iron Tr. Rev.* (Aug. 8, 1918) **63**, 344. Australia to refine own concentrates in future.

GUN-METAL, Notes on admiralty. H. S. Primrose, *Metal Ind.* (June 7, 1918) **12**, 437–40.

HARDNESS of metals, Notes on testing. J. W. Craggs, *Sci. Am. Sup.* (Aug. 10, 1918) **86**, 94–5.

HEAT treatment, System of. *Page's Engng. Wkly.* (June 28, 1918) **32**, 309.

LEAD-tin-antimony alloys. O. W. Elns, *Foundry Tr. Jnl.* (June, 1918) **20**, 308–9.

MELTING furnace, Tilting non-crucible. *Iron Age* (Aug. 15, 1918) **102**, 389.

MERCURY from its ores by sodium sulphide, Note on extraction of. C. H. Holland, New Zealand *Jnl. Sci. & Tech.* (May, 1918) **1**, 153–4.

METAL composition, U. S. Pat. 1268495. H. K. Sendell, *Off. Gaz.* (June 4, 1918) **251**, 121.

METAL industry, Non-ferrous. *Chem. Engng. & Min. Rev.* (June 5, 1918) **10**, 274–6.

METAL recovery, Canad. Pat. 184017. British Amer. Nickel Corporation, Ltd. *Canad. Pat. Off. Rec.* (Apr., 1918) 1320.

METALLIC-letter casting machine. F. W. Ayers, U. S. Pat. 1272887. *Off. Gaz.* (July 16, 1918) **252**, 661.

METALLOGRAPHY and heat treatment of metals used in aeroplane construction. F. Grotts, *Chem. & Met. Engng.* (Aug. 1, 1918) **19**, 121–8. Serial.

MOLYBDENUM ores in Canada, Mining and metallurgical treatment of. C. C. Mackenzie, *Trans.* Royal Canad. Inst. (Nov., 1918) **11**, 269–89.

NICKEL concentration limited. Method of extracting nickel. Canad. Pat. 183827. *Canad. Pat. Off. Rec.* (Apr., 1918) 1233.

NICKEL. International Nickel Co.'s refinery at Port Colborne. *Canad. Min. Jnl.* (Aug. 1, 1918) **39**, 262–3.

NODULIZING flotation concentrates. *Canad. Min. Jnl.* (Aug. 1, 1918) **39**, 255–7.

PHOSPHOR-BRONZE, Manufacture of. *Metal Ind.* (July 5, 1918) **13**, 4.

PHOSPHORUS alloy. Canad. Pat. 183581. A. J. Jeffs, *Canad. Pat. Off. Rec.* (Apr., 1918) 1114.

PLATES, Metal. British Pat. 116250. D. Davies, *Illus. Off. Jnl.* (July 31, 1918) 1538.

PLATINUM pie, Germany's finger in the. Editorial. *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 166–7.

PRECIPITATING gold with charcoal, Moore-Edmands process of. A. W. Allen, *Engng. & Min. Jnl.* (Aug. 10, 1918) **106**, 256–7.

PRECIPITATION from flue gas, Electrical. *Iron Age* (Aug. 1, 1918) **102**, 273.

PROCESS, Continuous, for recovering lead or zinc or both metals from their ores or from slag in the form of metal fumes, whereby the charge is mixed with fuel. U. S. Pat. 1269110. F. Ohlmer, *Off. Gaz.* (June 11, 1918) **251**, 311.

PROCESS for making alloys of phosphorus. U. S. Pat. 1268849. L. A. Jeffs, *Off. Gaz.* (June 11, 1918) **251**, 239.

REFINING metals and alloys. British Pat. 116277. Stabilimenti Biak. *Illus. Off. Jnl.* (July 31, 1918) 1546.

REFRACTORY oxides contained in metals of high melting points, Reduction of. H. P. Smith, *Metal Ind.* (July 12, 1918) **8**, 21.

RESISTANCE elements, etc., Alloy for. U. S. Pat. W. B. Driver, *Off. Gaz.* (July 30, 1918) **252**, 1096.

ROASTING ores, British Pat. 114954. A. G. Bloxam, *Illus. Off. Jnl.* (June 19, 1918) 1048.

SINTERING ores, British Pat. 115441. C. Giesecke, *Illus. Off. Jnl.* (July 3, 1918) 1233.

SINTERING ores, British Pat. 115023. J. Gayley, *Illus. Off. Jnl.* (June 19, 1918) 1073.

SMELTERY charges in British Columbia, Investigation of. *Canad. Min. Jnl.* (Aug. 1, 1918) **39**, 264.

SOFT METAL alloy and method of making same U. S. Pat. 1269000. W. L. Rice, *Off. Gaz.* (June 11, 1918) 281.

SOLDER without tin. C. W. Hill, *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 170.

SPELTER statistics for 1917. W. R. Ingalls, *Eng. & Min. Jnl.* (July 27, 1918) **106**, 176–81.

STELLITE, Notes on the manufacture and fabrication of. *Mach.* (May 30, 1918) **12**, 235–6.

SULPHUR and pyrites situation in relation to the fertilizer industry. A. D. Ledoux, *Am Fertilizer* (Aug. 3, 1918) **49**, 113–23.

TIN, Method of and apparatus for smelting. U. S. Pat. 1271200. E. N. Morrill, *Off. Gaz.* (July 2, 1918) **252**, 127.

TIN, Electrolytic recovery of. *Metal Ind.* (July 5, 1918) **13**, 8.

TIN, Shortage of. *Ry. Mech. Engr.* (Aug., 1918) **92**, 464.

TIN mine, Great Bolivian. *Min. Jnl.* (July 27, 1918) **122**, 449.

TIN, Consumption and conservation of. *Chem. & Met. Engng.* (Aug. 15, 1918) **19**, 175–6.

TIN, Give us. *Min. Jnl.* (June 29, 1918) **121**, 383–4.

TIN, Conservation of. *Am. Contr.* (July 6, 1918) **39**, 32.

TIN, Conservation of. *Power* (July 16, 1918) **48**, 108.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Acids and Ammonia
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Acid, Sulphuric
Illinois Zinc Co., Peru, Ill.

Agitators
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Amalgamators
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corpn., 115 Broadway, New York City.

Asbestos
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Asbestos Materials
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Assay Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway New York City.

Axles, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Balances and Weights
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ball and Tube Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Bearings, Ball
Gwilliam Co., 253 W. 58th St., New York City.

Bearings, Roller
Gwilliam Co., 253 W. 58th St., New York City.

Belting, Conveyor
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Belting, Elevator
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Belting, Transmission
Goodrich Rubber Co., B. F., Akron, O.

Bins, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Blasting Powder (See Powder, Blasting)

Blasting Supplies
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Blowers
General Electric Co., Schenectady, N. Y.

Blowpipe Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Brake Blocks
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Brick, Fire
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Buckets, Elevator
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Burners, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Burners, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway New York City.

Cableways
Flory Mfg. Co., S., Bangor, Pa.
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Cages, Hoisting
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Cages, Self Dumping and Plain
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Car Lifts, Automatic
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Carbide Lamps
Macleod Co., Bogen St., Cincinnati, Ohio.

Cars, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Castings, Brass
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Castings, Iron
Fuller-Lehigh Co., Fullerton, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Caustic Soda
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Cement Blast Guns (See Guns, Cement)

Cement Machinery
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Cements, Refractory
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

 [Please mention this BULLETIN when writing advertisers.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Chains
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Chemical Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Chemicals
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Chrome Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Ore (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chute Plates & Launder Liners
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Chutes
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Classifiers
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo
Deister Concentrator Co., Fort Wayne, Ind.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Coal and Ash Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Mining Machines
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coal Mining Plants
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Storage and Rehandling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coatings, Roof
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Collectors, Dust
Macleod Co., Bogen St., Cincinnati, Ohio.

Compass, Maas Patent Drill Hole
Derby, Jr., E. L., Agent, Ishpeming, Mich.

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Concentrators
Colorado Iron Works Co., Denver, Colo.
Deister Concentrator Co., Fort Wayne, Ind.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Condensers, Surface
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Contractors, Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Converters, Copper
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Converters, Electric, Rotary
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Conveyors, Belt
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Conveyors, Cable Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Chain Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Pan or Apron
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Screw
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Core Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coverings, Pipe and Boiler
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Crucibles
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Crushers, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg. New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Crushers, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown. Pa.
Worthington Pump & Machinery Corp'n. 115 Boradway, New York City.

Crushing Roll Parts
American Manganese Steel Co., McCormick Bldg., Chicago Ill.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Crushing Rolls (See Rolls, Crushing)
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Cupro-Magnesium Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Cupro-Vanadium
Primos Chemical Co., Primos, Pa.

Cyanide
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Cyaniding Equipment
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Dead Burned Magnesite
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Dewaterers
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

Dredging Machinery
Flory Mfg. Co., S., Bangor, Pa.

Drill Hole Compass (See Compass, Drill Hole)

Drills, Core
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Diamond
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Electric
Denver Rock Drill Mfg. Co., Denver, Colo.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Drills, Hammer
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Prospecting
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Rock
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Dryers, Ore
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.

Dryers, Rotary
Fuller-Lehigh Co., Fullerton, Pa.

Dryers, Sand and Gravel
Macleod Co., Bogen St., Cincinnati, Ohio.

Dumps, Rotary
Wood Equipment Co., McCormick Bldg., Chicago, Ill.

Dynamite
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Dynamos (See Generators, Electric)

Electrical Machinery
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Elevators, Bucket
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Emery Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

End Loaders (See Loaders, End)

Engines, Gas and Gasoline
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Engines, Haulage
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Engines, Hoisting
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Engines, Oil
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Engines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Explosives
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Fans, Ventilating
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Feeders, Ore
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Ferro-Chrome
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Molybdenum
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Ferro-Silicon
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Tungsten
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Ferro-Vanadium
Primos Chemical Co., Primos, Pa.

Filtering Paper
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Filters
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Fire Clay
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Flotation, Oil
Colorado Iron Works Co., Denver, Colo.

Flue Welding Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Fluorescent Calcium Tungstate
Primos Chemical Co., Primos, Pa.

Fluorspar (Domestic and Foreign)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Forges, Oil and Rivet
Macleod Co., Bogen St., Cincinnati, Ohio.

Forgings, Heavy
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Fuller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Furnaces, Assay
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Electric
General Electric Co., Schenectady, N. Y.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Furnaces, Flue Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Lead
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Mechanical Roasting
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Furnaces, Muffle
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Reverberatory
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Smelting
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Furnaces, Tire Heating
Macleod Co., Bogen St., Cincinnati, Ohio.

Gears
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Generators, Acetylene Welding and Cutting
Macleod Co., Bogen St., Cincinnati, Ohio.

Generators, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Grinders, Sample
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Grizzly & Riffle Bars (For Hydraulic Mines)
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Guns, Cement
Macleod Co., Bogen St., Cincinnati, Ohio.

Guns, Concrete
Macleod Co., Bogen St., Cincinnati, Ohio.

Gyratory Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Hangers, Mine
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Hitchings Mine Car
Macomber & Whyte Rope Co., Kenosha, Wis.

Hoists, Electric
Allis-Chalmers Mfg. Co., Milwaukee. Wis.
Flory Mfg. Co., S., Bangor, Pa.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoists, Skip
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Hoists, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoppers, Weigh
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Hose, Air
Denver Rock Drill Mfg. Co., Denver, Colo.
Goodrich Rubber Co., B. F., Akron, O.

Hydrated Ferric Oxide (For Gas Purification)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Hydraulic Mining Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Insulators, Third Rail
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Jackets, Water
Traylor Engineering & Mfg. Co., Allentown, Pa.

Jaw Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Jigs
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Laboratory Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Lamps, Acetylene
Macleod Co., Bogen St., Cincinnati, Ohio.

Lamps, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Lead Acetate
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Linings, Ball and Tube
Traylor Engineering & Mfg. Co., Allentown, Pa.

Linings, Brake
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Litharge
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Loaders, End
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Loading Booms
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Locomotives, Compressed Air
General Electric Co., Schenectady, N. Y.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Electric Trolley
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Locomotives, Gasoline
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Steam
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Storage Battery
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Low Carbon Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesia Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesite Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesium Metal (Ingots and Powder.)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnetic Pulleys (See Pulleys, Magnetic)

Manganese Dioxide (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Manganese Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Meters, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Mica
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Mills, Ball, Tube and Pebble
Allis-Chalmers Mfg. Co., Milwaukee, Wis
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Mills, Chilean
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Mills, Stamp
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n. 115 Broadway, New York City.

Mine Car Hitchings (See Hitchings, Mine Car).

Molybdate of Ammonia
Primos Chemical Co., Primos, Pa.

Molybdate of Calcium
Primos Chemical Co., Primos, Pa.

Molybdate of Soda
Primos Chemical Co., Primos, Pa.

Molybdenum Metal
Primos Chemical Co., Primos, Pa.

Molybdenum Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Molybdic Acid
Primos Chemical Co., Primos, Pa.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Muffles
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ore-Bedding Systems
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Milling Machinery
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Ores, Buyers and Sellers of
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Oxy-Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Packings, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.
Goodrich Rubber Co., B. F., Akron, O.

Painting Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Pipe Insulations
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Plate Metal Work
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Platinum Wire, Foil & Ware
Heil Chemical Co., Henry, 210-214 S. 4th St. St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Powder, Blasting
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Powdered Coal Equipment
Fuller-Lehigh Co., Fullerton, Pa.

Power Transmission Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Presses, Filter
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pulleys, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Pulverizer Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Pulverizers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Pulverizers, Coal and Coke
Fuller-Lehigh Co., Fullerton, Pa.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pulverizers, Ore
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Acid
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Hydraulic Pressure
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Pneumatic Air Lift
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Pumps, Power
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Sand
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pumps, Sinking
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Stuff
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Track
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pyrometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Quarrying Machinery
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Quicksilver
Beer, Sondheimer & Co., 61 Broadway, New York City.

Refractories
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Respirators
Goodrich Rubber Co., B. F., Akron, O.
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.

Revolving Screen Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rock Drill Steel (See Steel, Drill)

Rods, Drill
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.

Roller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rolls, Crushing
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Roofings, Asbestos and Rubber-type
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Rope, Wire
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rope Fastenings, Wire
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rubber Goods, Mechanical
Goodrich Rubber Co., B. F., Akron, O.

Samplers, Ore
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Scorifiers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Screens, Bar
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Screens, Perforated Metal
Jeffrey Mfg. Co., 902 N. 4th St., Columbus. Ohio.

Screens, Revolving
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Screens, Shaking
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Separators, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Shaft Sinking and Development Work
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Sharpeners, Drill
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Silica Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Skip Hoists (See Hoists, Skip)

Slings, Wire Rope
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Smelters
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Smelting Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Soda Ash
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Spelter
Illinois Zinc Co., Peru, Ill.

Spiegeleisen
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Sprockets
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Stamp Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Steel, Crucible
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.

Steel, Drill, Hollow and Solid
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
Denver Rock Drill Mfg. Co., Denver. Colo.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Steel, Tool
Colonial Steel Co., Keystone Bldg., Pittsburgh. Pa.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.

Stokers
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Tables, Concentrating (See Concentrators)

Test Lead
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thawers, Switch
Macleod Co., Bogen St., Cincinnati, Ohio.

Thermometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thickeners, Slime
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.

Tipple Machinery Equipment
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Torches, Cutting and Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Towers and Bridges, Stocking and Reclaiming
Robins Conveying Belt Co., Park Row Bldg., New York City.

Tramways, Wire Rope, Aerial
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Transformers, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Traps, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Tungstate of Ammonia
Primos Chemical Co., Primos, Pa.

Tungstate of Soda
Primos Chemical Co., Primos, Pa.

Tungsten Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Tungsten Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Tungsten Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Tungstic Acid
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Turbines, Hydraulic
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Valves, Pump
Goodrich Rubber Co., B. F., Akron, O.

Vanadate of Ammonia
Primos Chemical Co., Primos, Pa.

Vanadic Acid
Primos Chemical Co., Primos, Pa.

Vanadium Chloride
Primos Chemical Co., Primos, Pa.

Vanadium Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Ventilating Fans (See Fans, Ventilating)

Wagon Loaders
Jeffrey Mfg. Co., 902 N. 4th St., Columbus Ohio.

Weigh Hoppers (See Hoppers, Weigh)

Wheels
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Wheels, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Wire, Iron, Steel and Copper
Roebling's Sons Co., John A., Trenton, N. J.

Wire Mechanism (Lever Control)
Gwilliam Co., 253 W. 58th St., New York City.

Wire Rope (See Rope, Wire)

Wires and Cables, Electrical
General Electric Co., Schenectady, N. Y.
Goodrich Rubber Co., B. F., Akron, O.
Roebling's Sons Co., John A., Trenton, N. J.

Zinc Dust
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Zinc Sheet
Illinois Zinc Co., Peru, Ill.

ALPHABETICAL LIST OF ADVERTISERS

(With Summary of Products)

See pages 38–49 for Classified List of Mining and Metallurgical Equipment

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

ALPHABETICAL LIST OF ADVERTISERS (Continued)

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

NOVEMBER, 1918

Bulletin of the American Institute of Mining Engineers

PUBLISHED MONTHLY

SPECIAL FEATURES

Bulletin of the American Institute of Mining Engineers

No. 143 NOVEMBER 1918

CONTENTS

CURRENT MATTERS

TECHNICAL PAPERS

ADVERTISING

BULLETIN OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

PUBLISHED MONTHLY

No. 143 NOVEMBER 1918

Published Monthly by the American Institute of Mining Engineers at 212-218 York St., York, Pa., H. A. Wisotskey, Publication Manager. Editorial Office, 29 West 39th St., New York, N. Y., Bradley Stoughton, Editor. Cable address, "Aime," Western Union Telegraph Code. Subscription (including postage), $10 per annum; to members of the Institute, public libraries, educational institutions and technical societies, $5 per annum. Single copies (including postage), $1 each; to members of the Institute, public libraries, etc., 50 cents each.

Entered as Second Class matter January 28, 1914, at the Post Office at York, Pennsylvania, under the Act of March 3, 1879.

NEW YORK MEETING, FEBRUARY 17-20, 1919

In preparation for the 119th meeting, New York, Feb. 17 to 20, 1919, the following committees have been appointed:

Committee on Arrangements

Allen H. Rogers, *Chairman*. W. S. Dickson, *Secretary*.
J. E. Johnson, Jr. F. T. Rubidge. P. G. Spilsbury.
H. C. Parmelee. Forest Rutherford.

Committee on Annual Dinner

F. T. Rubidge.
E. B. Sturgis.

Committee on Luncheon

Forest Rutherford, *Chairman*.
E. Maltby Shipp.

Committee on Patriotic Meeting

H. C. Parmelee, *Chairman*.

CLOSING DATE FOR PAPERS FOR THE NEW YORK MEETING

The Committee on Papers and Publications has set Dec. 1, 1918, as the closing date for the receipt of manuscripts of papers intended for presentation at the New York Meeting, in February. Such papers as are to be submitted to technical committees of the Institute, before submission to the editors, should be sent to such committees in ample time to allow them to be forwarded to us on or before the above date. In order to permit publication in the January *Bulletin*, for the sake of wider circulation before the meeting, it is desirable for manuscripts to be received earlier than the date mentioned. Papers received toward the end of November will probably not appear in a Bulletin earlier than that for February, 1919, which will allow only a few days for publication and circulation before the meeting.

MILWAUKEE MEETING

The One Hundred Eighteenth Meeting of the Institute was held at the Milwaukee Auditorium, on Tuesday, Oct. 8, to Thursday, Oct. 10, inclusive, 1918, under the joint auspices of the Committee on Iron and Steel (Chairman, Prof. J. W. Richards), and the Institute of Metals Division (Chairman, William M. Corse), and simultaneously with sessions of the American Foundrymen's Association and of the American Malleable Castings Association. It was preëminently a war meeting. It was attended by 104 members of the Institute.

The social features, so far as the members of this Institute were concerned, were slight, but generous and appropriate entertainment was offered to the ladies, consisting of automobile sight-seeing trips, reception, concert and dance on Tuesday evening, a theatre party Wednesday evening, and a banquet in the Auditorium Thursday evening, at which the speakers were Charles M. Schwab, Director General of the United States Shipping Board Emergency Fleet Corporation, Major A. Radclyffe Dugmore, and W. H. Blood, Jr., Assistant to the President of the American International Shipbuilding Corporation.

A joint session was held on Tuesday morning, at which an address of welcome was delivered by Hon. Emanuel L. Phillipp, Governor of Wisconsin, with a response by Benjamin D. Fuller, President of the American Foundrymen's Association, and the following addresses:

Activities of the Army Ordnance Department, Especially as Applied to Foundry Matters. By C. S. Koch, Cannon Section, Production Division, Ordnance Department, Washington, D. C.

Coöperation between the Railroad Administration and the Metal-working Industries. By E. D. Brigham, Manager, iron ore, coal and grain traffic, United States Railroad Administration, Duluth.

Modern Methods of Transferring Skill, illustrated by military films. By Major Frank B. Gilbreth, Providence, R. I.

On Wednesday morning, the Institute of Metals Division conducted a symposium on the conservation of tin, while the iron and steel section covered the programs of both the iron and steel and the coal and coke sessions, as scheduled in the announcement published in the September *Bulletin*. The symposium on tin will be published in its entirety in the December *Bulletin*.

On Wednesday afternoon and Thursday morning the Institute of Metals Division conducted the sessions previously announced for these occasions, dealing mainly with the metallurgy of copper, zinc, brass, bronze, and amalgams.

A complete list of all the papers presented at these sessions will be printed in the December *Bulletin*, which will also contain the discussion elicited by each paper.

The plants opened to inspection by visitors to Milwaukee included some very large industrial concerns, such as the Allis-Chalmers Manufacturing Co., the Bucyrus Co., the Wisconsin Gun Co., the Worthington Pump and Machinery Corporation, and many important iron and steel foundries, as well as the pulverized-coal boiler plant of the Milwaukee Railroad and Electric Power Company.

LOCAL SECTION NEWS

NEW YORK SECTION

ALLEN H. ROGERS, *Chairman*, H. C. PARMELEE, *Vice-chairman*,
FOREST RUTHERFORD, *Vice-chairman*,
W. S. DICKSON, *Secretary*, 71 BROADWAY, NEW YORK, N. Y.
J. E. JOHNSON, JR. F. T. RUBIDGE, *Treasurer*, P. G. SPILSBURY.

A meeting of the New York Section was held at the Machinery Club on Friday evening, Oct. 4, 1918, the Chairman, Allen H. Rogers, presiding.

THE CHAIRMAN.—Most of us, I suppose, have been affected more or less by the request of the Fuel Administration that we leave our automobiles standing in the garages on Sundays. We shall all be interested in hearing about the situation that has called forth this request, and the Oil Administrator, Mr. Requa, has kindly come from Washington to tell us about it.

MARK L. REQUA.—I am very glad to tell you about the oil problem during this war period.

The United States is supplying by far the greater part of all the petroleum products consumed in Great Britain, France and Italy. In addition to this, we have had to supply a marked increase in our domestic consumption, not only of the refined products, but of fuel oil as well. The combination has put a strain on the oil industry, which it is very difficult to meet. The oil companies, being under contract, had no option as to who should get their oil first, and they were delivering *pro rata* to everybody; manufacturers of furniture were getting oil with the same regularity as those who were making aeroplanes or munitions, and the oil companies felt that something should be done.

The first order with which I had anything to do was the priority list for the delivery of fuel oil. That list contained 12 classifications, beginning with bunker fuel and railroads, and you will realize the complexity of the situation when you hear that munitions plants are in class 11. The priority list held during the winter, but transportation became so bad, because of the number of ships that were taken for trans-Atlantic use, that some of the oil companies were not able to deliver more than about 60 per cent. into class 5, and nothing beyond that point. To add to the troubles, the tank-car mileage fell off. The average for 1917 was about 36 miles per car per day; in January, 1918, it dropped to about 8 miles, and it must have been nearly zero in the early part of February. Because of the extremely severe winter, furthermore, pipe lines were not delivering anywhere near their normal capacity.

A new priority list has recently been promulgated, introducing a few slight changes. Natural gas has been brought under its provisions, and it has been extended to include the Pacific Coast, which was not considered necessary last winter. The situation in the gas industry is not satisfactory; it is estimated that there will be a decrease of 10 to 20 per cent. in the quantity of natural gas available this winter, as compared with last winter.

It is not possible to meet satisfactorily the demand for oil. We could probably put 100,000 bbl. a day into England, and another 100,000 bbl. into France, if we had adequate transportation, and I know we could dispose of 100,000 bbl. a day along the Atlantic seaboard, so the whole question is in one of supply. The growth of the oil industry from 1861 to 1917 has averaged 9.5 per cent. increase every year; from 1904 to 1917, the annual increment has been about 8.5 per cent. We require this year, to meet the normal expected increase, not less than 25,000,000 bbl. of oil above last year's output, and I presume, because of the war demands, the increase will be greater than that.

It is obviously very difficult to provide transportation for that tremendous annual increase in the face of the demand for transportation of material for other purposes. The pipe lines to the Atlantic seaboard are running to capacity; these lines have been augmented this summer, increasing their capacity by about 25,000 bbl. The pipe lines to the Gulf are also operating nearly to capacity. These two pipe-line systems are delivering about half of the production east of the Rocky Mountains. The remainder is sent inland and is distributed by tank cars, and if it reaches the eastern seaboard at all it arrives in the form of refined product. The Mexican situation has been very unsatisfactory, although we have been able to bring a little more oil out of Mexico this year than last year.

The draft on stocks in 1917 was about 21,000,000 bbl. but during the first 6 months of this year, as compared with the same 6 months last year, the draft has increased 22 per cent.

I am glad to say that there is a silver lining to the cloud; a new oil field is being developed in Texas which bids fair to meet all the requirements for some time to come. This is the Ranger Field, in Eastland County, about 100 miles west of Dallas. The oil is found at a depth of 3000 or 3200 ft., the wells are large, the oil is of excellent quality, and there is a production of about 20,000 bbl. a day at the present time.

Recent conferences have decided upon the building of pipe lines from the Ranger Field to tide-water; these will be equipped to carry about 100,000 bbl. of oil a day, and it is estimated that within 9 months from now they will be running to capacity.

The oil from this new field will also go north to Oklahoma, where there are many refineries that are not now adequately supplied with crude oil. As a matter of fact, the refinery capacity of the country is about 30 per cent. in excess of the crude supply, or was, some months ago, when an investigation was made.

On account of the lack of oil at the smaller Oklahoma refineries, keen competition grew up there, which had to be stopped. When I undertook this work, the posted price of oil in the Oklahoma Field was 25 c. a barrel less than it is at present, and in Texas, where there was no posted price, it was 50 c. a barrel less than now. I think the oil producers of Texas took advantage of certain conditions to advance the price unduly. They were entitled to an increase—whether it should have been 50 c. a barrel, or something less, I do not know that we can determine accurately —but my belief is that they got about 15 c. more than they were entitled to. There was a great deal of criticism that I should have permitted the advance at that time, but after a careful field investigation by several agents, who were practical oil men from California, and hence were not particularly interested in the eastern situation, and after conference

with the marketing companies and the producers, I became satisfied that it was wise to permit an advance of 25 c. a barrel in Oklahoma. We were not getting the oil we required, and nowhere near it; we ran 20-odd million barrels behind last year. The consensus of opinion was that a little more stimulus was required to produce the oil necessary in Oklahoma; so the posted price was advanced 25 c. a barrel by the Prairie Pipe Line, and has been maintained at that figure ever since.

There is no provision in the Lever Bill—which is the authority under which both Mr. Hoover and Dr. Garfield are operating—for price-fixing; it does permit regulation of profits. Section 25 of the bill does provide for the fixing of coal and coke prices, but that section has nothing to do with any other part of the bill, and, as a matter of fact, was added as an afterthought, to make unnecessary the passage of another bill; hence the Fuel Administration has direct authority to fix the prices of coal and coke, but not of oil. As a matter of fact, it does not need this authority, for two reasons—first, because the posted price in the field can be regulated at any time; secondly, because the industry has expressed and carried out a complete harmony of action, and has exhibited unvarying willingness to conform to the expressed wishes of the Fuel Administration. Thus, while as a matter of law no regulation of prices is possible, as a matter of fact, prices can be and have been regulated, by the voluntary acts of the industry.

Of the 100,000,000 bbl. of stored oil available in the eastern United States, at least 80 per cent. is in the hands of the former Standard Oil group, and the entire number of companies owning the remaining 20 per cent. is probably not 25 or 30; the oil storage of the country is actually in the hands of a very few companies. On my requesting these companies to allocate some of their oil to the smaller refineries, they offered 20,000 bbl. a day for allocation. Some 18,000 bbl. of it has already been placed, and the rest of it will be distributed in a few days, and if that is not enough, we will ask for another 20,000 bbl. to be allocated. The smaller companies, at first, were slow to realize their opportunity, and quite a long time went by before they made any effort to avail themselves of it.

At the time the stabilization of price was undertaken, a voluntary agreement was entered into by the producers and refiners that to the base price of $2.25 should be added certain maximum premiums, which would thereby establish the different grades of oil in the Oklahoma field; the premiums ranged from 10 c. to as high as $1.50 a barrel. It was also stipulated in this agreement that no oil should be diverted from the channels in which it was then running, without a direct permit. This purely voluntary agreement immediately stopped any further advance in the price of crude oil, and they have held pretty successfully to those prices ever since.

I undertook this work with the Fuel Administration in the firm belief that it would be more or less of a calamity if it should become necessary for the Government to take over the oil industry, and I have continuously pleaded with the industry so to conduct itself as to leave no opening that would justify the Government in taking control and operating it. Because of the acute lack of supplies, I felt that the situation had to be handled with the greatest delicacy, that nothing should be done that would retard or discourage the industry, or interfere with the output of petroleum products. So I said to the oil operators' Petroleum War Service Committee that I hoped it would continue its organization just

as it was, except that it should be enlarged and made more representative, and extended to every oil field in the United States. This has since been done. There are sub-committees covering every phase of the problem—oil-well supplies, the refiners, the producers, the jobbers, the marketers, and there is a committee in each of the fields to deal with its own particular problems.

All of the shipments for the Allies are allocated by the Secretary of that committee, and a representative from my office. Prices were agreed upon early last spring, and have remained constant up to the present time.

To avoid possible criticism as to throwing the business into the hands of large marketing companies, I made an agreement with the large companies that, after the allocation, if anyone felt slighted, or that he wanted more of the business, he should have it; but that the large companies, the Standard, the Texas, the Tidewater, the Gulf, the Mexican Petroleum, and others, would stand ready to supply any deficit during the allocation period. This plan has worked perfectly satisfactorily and there has been no demand from anyone for a larger part of the business than was allocated to him; in fact, many of the companies have not cared to take their whole allocations—the domestic prices in their own particular localities appeared to be more attractive than the Seaboard prices for export.

The requirements for overseas are growing very rapidly, and I am sure that they will continue to grow still more rapidly after the first of next year; but I am equally sure that, whatever they may be, we shall be able to meet them. To do that, of course, may require a certain amount of cutting and fitting at home, but that will be done.

We are having an exhibition of what is one of most remarkable demonstrations of American solidarity that has happened since the war—the "gasless Sunday." This has been successful to the extent of making it possible to load 10 cargoes, about 500,000 bbl., of gasoline for Europe that otherwise could not have gone. The stock of gasoline available for the Atlantic Seaboard got dangerously low. There was an argument all summer in the Petroleum War Service Committee as to whether we should get through the year or not. We kept going as long as we could, until one day General Pershing wanted 90,000 drums of gasoline in addition to all that had gone forward. Curtailment appeared unavoidable, and took the form of a request for the "gasless Sunday;" this was nothing but a request, but it was much more effective than any order would have been. The whole affair has made a profound impression upon the American people, by showing how absolutely solidly the whole nation is behind the war, and behind the Government.

We have encountered one problem which would not arise ordinarily—that is the problem of aviation gasoline. The end point of ordinary gasoline is placed at about 430° F. The British aviation gasoline has an end point of 302°; the grade of gasoline that we manufacture for special fighting use has an end point of 257°. This is expensive to manufacture, as compared to ordinary gasoline, and the percentage obtainable from a given oil is much less. The solution of the problem was made possible only by some form of conservation.

The President some time ago created the Committee for the Standardization of Petroleum Specifications. We have undertaken to correlate all of the petroleum products specifications of the Government departments—such as lubricating oils, kerosene, gasoline, and everything

else—and issue standards that will be known as U. S. Government Specifications. That committee comprises representatives of the Army and Navy, the Shipping Board, the Railway Administration, and the Fuel Administration. A delegation representing the Inter-Allied Petroleum Commission, which was convened in London, conferred with us on the subject of our specifications, and we authorized yesterday the publication specifications standardizing the various grades of gasoline. There will be motor spirit; the domestic grade, used for domestic flying purposes; the export grade, which corresponds very closely with the British specifications; and a fighting grade, which is practically a repetition of the French specifications. The other products are to be standardized as rapidly as possible.

Because of the tremendous increase in munitions manufacture, the demand for fuel oil has increased, a great deal of this being used in heat treatment; we must supply a quantity considerably in excess of what has been supplied heretofore. We shall meet the situation fairly completely, especially if we get the tank ships that are now promised for bringing oil from the Gulf and from Mexico.

It is going to be necessary for us to continue a policy of conservation, especially of gasoline, and my idea is to evolve some other plan of voluntary conservation. The present "gasless Sunday" plan obviously cannot continue very long, because it is so largely class legislation; a large portion of the population is unable to use automobiles on any other day than Sunday. Our gasoline production increased 27 per cent. during the first 6 months of this year, as compared with the first 6 months of last year, but consumption during the same period increased 31 per cent. The domestic exports increased 24 per cent. During the same period, the fuel-oil production increased 21 per cent. while consumption increased 22 per cent. Hence the problem relates not only to production and refining, but it is essentially a problem of transportation.

We produced about 340,000,000 bbl. of oil last year, and shall produce considerably more this year, owing largely to the Ranger Field. We shall have to draw on storage for considerably more than we did last year, but the outstanding feature in the situation east of the Rocky Mountains is that we have a new oil field which apparently is able to supply any deficiency owing to a decline in existing fields. I have not the slightest doubt that the American oil industry will be able to meet every demand that will be made upon it from Europe. We are producing today practically 70 per cent. of the oil of the world, and with what we can get from Mexico we shall meet any situation, so far as the oil itself is concerned. Transportation is another problem which must be dealt with separately, and of the two I think it is the more difficult.

The situation with regard to kerosene is more acute than that of gasoline. You have not felt it yet, and perhaps you will not feel it at all, because the industry has been asked to run more kerosene, and they are going to do that. The price of kerosene has increased less, proportionately, than that of any other commodity, which is one reason why more kerosene has not been made. In some parts of the country, notably in Pennsylvania, last winter, it was more profitable to throw the kerosene into the fuel oil than to make a refined product. The only saving factor in the situation has been that kerosene exports declined more than 30 per cent., owing to the inability to secure ships to move it. A large part of the decline occurred in shipments to the Orient, but the decline in

exports to Europe was also marked, although it did not run into so great tonnage; shipments to Europe are increasing at the present time.

J. E. JOHNSON, JR.—I have been wondering whether there is any possibility that the shortage in gasoline supply could be relieved by the development of the Diesel engine for use on trucks, where starting and stopping may not be so important as in automobiles.

MR. REQUA.—I do not think the development of the Diesel engine will be a factor during the war period.

I have been reminded of one idea to which I wish to refer. I was interested the other day in making a comparison between the value of coal and oil, and I find roughly that the value of the oil products, including natural gas, for 1918 will be about $1,500,000,000, while that of coal will be about $1,600,000,000, the coal being valued at the mouth of the mine, and the oil at the door of the refinery. Another significant feature is that the value of the gasoline was about 45 per cent. of the entire value of the oil produced.

THE CHAIRMAN.—A number of us are ignorant of the technology of the oil business. Mr. Carl H. Beal, of the Bureau of Mines, is here, and perhaps he will tell us something about the proportions into which crude oil is divided, how they get gasoline from natural gas, and how they crack the heavier products to get the lighter products.

CARL H. BEAL.—In regard to the gasoline question, Mr. Requa has covered that very well, although a few more figures might impress upon your mind the seriousness of the situation that led to this request for a "gasless Sunday."

Counting our demands for export, we had to have about 10,000,000 bbl. of gasoline for each month during the summer. We used about 8,500,000 bbl. in this country, and were exporting an average of 1,500,000 bbl. In the winter, especially in the cold parts of the country, there is very little motoring, so that the actual demand for gasoline is lower in winter than in summer. In fact, we expect to produce enough during the fall and winter, and place it in storage, to carry us through the summer months. August and September are usually the worst months—more gasoline is used in those months than in any other two months in the year.

During August, our stocks of gasoline were decreasing at the rate of about 1,500,000 bbl. a month. Our production of 8,500,000 bbl. was only enough for our domestic consumption, and we had to provide the export gasoline from some other source. When Mr. Requa requested the "gasless Sundays" we had only about 2 or 3 weeks' supply on hand. For that reason, I think the whole country should be grateful to the Oil Administration for the way it has handled the situation. The seriousness is over for the present, and we can now begin to replenish our stocks in preparation for next summer. I agree with Mr. Requa that we shall undoubtedly have to practice further conservation or restriction in the use of gasoline. I do not see how, with our present supply of crude oil and our present refinery output, we can hope to supply all that will be wanted next summer.

As to the sources of our gasoline, casing-head oil is one; I estimate this year we shall produce about 8,000,000 bbl. of gasoline from casing-head oil. This gasoline is produced by two ordinary methods: by compression and refrigeration, and by absorption. Some of the gasoline produced from casing-head oil is all right for aviation motors, but some is not. The refined gas is apparently satisfactory; that which is not reliable

for aviation purposes may be used for blending the heavier products from the distillation of crude, such as kerosene, or heavy engine gasoline.

Another source of gasoline is in the cracking tubes; the Burton process, controlled by the Standard Oil Co., is the principal producer of cracked gas, and consists in heating the gasoline under pressure. The molecules of the oil are rearranged into a specific crude oil from which is distilled ordinary gasoline. This year we shall produce about 6,000,000 bbl. of cracked gasoline.

I estimate that the output of the third type of gasoline, known as straight-run gasoline, will be about 74,000,000 bbl. That will give us a total production of about 88,000,000 bbl. Last year we produced between 70,000,000 and 75,000,000 bbl. of gasoline, of which the casinghead output was 5,000,000 barrels.

Mexico sent us last year about 30,000,000 bbl. of crude and refined product. The refined product consisted of fuel oil and distillates—the tops, or unrefined gasoline. Every barrel of tops presents the necessity of our running through storage 5 bbl. of our own domestic oil; in other words, it takes about 5 bbl. of crude oil to make 1 bbl. of gasoline in this country. The distillates imported from Mexico consist largely of gasoline, so that the more of them we can import the easier it becomes for our refineries.

I think we have about reached the zenith of our oil production. We have been very ambitious in developing our supplies and evolving methods for getting the oil out of the ground, and our methods have reached a high degree of perfection. Our fields have been more completely worked than those of any other country; the fields in many other countries have not been touched.

I ought to mention the possible utilization of our shale deposits. Enormous quantities of oil are locked up in the shales, probably many times greater than the original amount of oil we had in the sand, and there is no question that we shall some time utilize these shales; in fact, they are the only bright spot ahead of us, so far as our oil supply is concerned.

Shales are scattered all through the Rocky Mountain region, and many of them will average as much as a barrel of oil per ton of shales. The principal drawback has been that the price of shale products has not been high enough to justify the erection of plants for the distillation of the oil from the shale. I do not know of a single retort running commercially at the present time. I know of 22 different processes that are being advertised, and many more companies have been organized, but I do not know of any that are making money. We are convinced that this is a great resource of the United States, but it will be several years before these shales can be retorted properly.

The Government feels that it is its duty to investigate the shale industry as soon as it can, because it is necessary to try out all the processes that look at all feasible, to determine which one should be adopted for a certain kind of shale. To that end, the Secretary of the Interior, and Mr. Manning, of the Bureau of Mines, are both anxious to get under way some experimental work on the extraction of oils from shales.

MARK L. REQUA.—Mr. Beal touched on the subject of our future resources. The Geological Survey made a very interesting computation which would indicate that we have exhausted about 40 per cent. of the entire known petroleum resources of the country. Supposing that additional oil areas will be discovered in the United States, equal in pro-

ductivity to those already known, and assuming an annual consumption of 400,000,000 bbl., we have enough oil to last for about 30 years to come. The Survey has also made another calculation, which shows that the known oil shales will produce a quantity of oil much in excess of the petroleum estimate I have quoted. Of course, there will be oil developments in other parts of the world, notably in Mexico.

CAPT. D. M. LIDDELL.—Mr. Requa has expressed the idea that conservation according to the present plan is class discrimination. Will he please tell us whether he thinks that the present laws and regulations cover all the ground necessary for proper conservation of gasoline? It seems to me that if the problem is mainly one of transportation, the sooner we curtail consumption, the better.

MR. REQUA.—A voluntary effort to meet the situation, from my point of view, is more desirable than anything that could be accomplished by the issuing of an order. I do not think it is possible to secure any additional legislation on this subject.

Few realize the intimate relationship existing between all these oil products. For instance, if you manufacture more fuel oil, you will get more of something else at the same time, more gas-oil or gasoline, kerosene or lubricating oil, all of which must be disposed of. Gasoline is only one, but a very important part of the whole, amounting to 45 per cent. of the total value at the present time.

One obvious source of additional quantities of light gas-oil or fuel oil is to stop cracking. That will immediately release 6,000,000 bbl. of oil a year that are now going for fuel oil, but at the same time cause a deficit of 6,000,000 bbl. of gasoline, which must be gained by curtailing its consumption. There is no "joy-riding" with fuel oil, but there is a good deal of it with gasoline, and that is where we shall have to apply our efforts at conservation.

Some have suggested conservation by card rationing, as is done in Europe. I doubt if we shall do this, but the plan has the great advantage of being perfectly elastic. We could zone the country into ten, a dozen, or more zones, and each user of gasoline would have his card punched every time he bought any. You might find that in New England next week, for example, there was a threatened shortage of 20 per cent.; it would only be necessary then to publish a notice in New England that the gasoline card was good for only 80 per cent. of its face, and the thing is done. If there was a surplus, the card might be made good for 110 per cent.; or the card system might be repealed altogether. Of course, it is entirely feasible to issue 5,000,000 cards in the country and control them, but this means a great deal of supervision, and if conservation can be brought about by voluntary effort, it should be done in that way. The oil industry itself is very much opposed to the card system because, they say, it immediately opens the door for unbelievable graft. Every truck should have its full requirements, we must not stop the necessary machines, but what should be curtailed is the unnecessary use of the automobile, which, if stopped entirely, would liberate 20 per cent. of the gasoline now consumed.

After a vote of thanks to Messrs. Requa and Beal, the meeting adjourned.

W. S. DICKSON, *Secretary*.

MONTANA SECTION

N. B. BRALY, *Chairman* B. H. DUNSHEE, *Vice-chairman*
E. B. YOUNG, *Secretary-Treasurer*, 526 Hennesy Building, Butte, Mont.
F. W. BACORN C. D. DEMOND

According to notice, the Montana Section held its regular fall meeting in the Montana Hotel, Anaconda, on Saturday evening, Oct. 5, 1918. The technical session was preceded by a dinner at which 73 members and guests were present. Chairman N. B. Braly presided at both.

After the reading and approval of the minutes of the last regular meeting, Feb. 1, 1918, the principal speakers of the evening were introduced. The Executive Committee had previously arranged for a discussion or symposium on "The Labor Situation," the discussion to be opened by F. W. Bacorn. He was followed by Scott Leavitt, Federal Director for Montana of the U. S. Employment Service, who spoke on "The Labor Policies of the Federal Employment Service." E. A. Hewitt then spoke on the "The Employment System of the North Butte Mining Co." Much discussion followed these papers, participated in by C. W. Goodale, J. L. Bruce, Frederick Laist, and D. C. Bard.

The session closed with a report by F. A. Linforth on the Colorado Meeting, which was extremely interesting to those who had been unable to attend it.

E. B. YOUNG, *Secretary.*

WOMAN'S AUXILIARY

CENTRAL AMERICANIZATION COMMITTEE

Chairman, MRS. C. C. BURGER

This committee reports progress in drawing up circulars on the subject of Americanization, to be sent to all the branches of the W. A. A. I. M. E.

It is greatly to be desired that all our members should interest themselves personally in work that can be done among the women and children in the mining districts in the way of Americanizing those of foreign birth or extraction; so much can be accomplished by individual interest and sympathy.

CENTRAL EMERGENCY COMMITTEE

Chairman, MRS. H. N. SPICER

This committee reports as follows, on work done since the last report, handed in on June 5, 1918:

Owing to the absence of a number of the members of the Emergency Committee during the summer, it was not possible to carry out any great amount of work. With the idea of renewing activities, a meeting was called for Sept. 14, but only three members were able to attend, so it has not yet been possible to formulate any definite policies.

We regret to report that at this meeting we received the resignation of our secretary, Miss Olga Ihlseng, who is taking up work in Washington.

Since June, the following knitted garments have been handed in and are now packed and ready for delivery to the 27th Regiment: 135 pair of socks, 1 khaki helmet, 1 khaki vest, 1 muffler, 9 sweaters.

The Emergency Committee has to thank the Denver Section of the W. A. A. I. M. E. for its contribution of 23 pair of socks, 2 sweaters, and 1 khaki vest, which are included in the above. The Columbia Section is also forwarding socks for our 27th Regiment.

At the present time, the Emergency Committee has the following wool on hand for distribution: 220 lb. of gray sock wool, 10 lb. of khaki sweater wool. The wool is weighed and issued to members of the W. A. A. I. M. E. on application. They must return the same weight of wool in knitted garments.

CENTRAL FOREIGN WAR RELIEF COMMITTEE

Chairman, MRS. H. H. KNOX

The report of the chairman of the committee, for work since the last report (May 31), to the Director of the New York Section, is as follows:

Through the addresses and pleas of Mrs. Pauline Sands Lee, the sum of $4118 has been contributed for the maintenance of a dispensary in France for women and children under the auspices of the American Fund for French Wounded. Of this sum, $3000 has been remitted for the support of the dispensary during the ensuing year, while the balance remains on hand to be applied to the following year. This dispensary will bear the name of the New York Section, and it is earnestly hoped that the members of the Section will contribute hospital supplies, which include garments for women and children, to be forwarded through the American Fund for French Wounded.

It is gratifying to record that the President of the Auxiliary, Mrs. R. C. Gemmel, of Salt Lake City, has expressed sympathy with the purpose of this committee and has declared her intention of proposing its adoption by the other sections, thereby working toward that unity of purpose which makes for effectiveness.

COLUMBIA SECTION

From the Chairman of the Columbia Section, we receive, as always, most interesting reports of the work of the various branches and members in her section. We could wish that all directors would send in similar reports, for it is stimulating to read "One of our members 'ranches' two days per week, cans and preserves two days, then catches up with her housekeeping and if possible knits a bit;" and, "our ladies are knitting socks even during the excessive heat ....one of our members, with several friends, heard of some cherries going to waste because there were no pickers, visited this place, picked 100 lb. of fruit to take to the Spokane Children's Home. They were so thankful for them, as in the stress of giving to the war sufferers we forget our own dependent children." "A few weeks ago, our Auxiliary took the rest of our store of fruits, vegetables and jams to this same Children's Home—88 quarts of fruit and 35 glasses of jelly (some of the jellies were in quart jars). The Benevolent Society assures us it was a splendid treat to the little ones. Mrs. Linney and I noted that the shelves at the Home were quite bare and the contribution was of help to them."

It is most stimulating and encouraging to read how in Moscow, Idaho, and Silverton, B. C., where there are only single members, these ladies

are working assiduously in the Red Cross and at War Gardens, and how at Cornucopia, Oregon, with a population of 250 and a payroll of 160 men, over $3000 was raised for the Red Cross and $800 for the Y. M. C. A. This last, of course, was not the work of the Auxiliary, but one wonders whether if the ladies of one section, or of two or three sections, combined, they might not be able to raise funds for the establishment of more dispensaries for women and children in France, to bear the names of their respective sections. The New York Section has led the way, will not others join? Possibly this epidemic of Spanish influenza in the Eastern States, where it has been impossible to get doctors and nurses for the sick, may bring home to us the desperate need of France, where civilians cannot obtain the help of a doctor, and children, the children needed to rebuild that glorious country, are dying every day for lack of ordinary medical and surgical treatment. May I quote the instance of a lady, the news of whose death in France reached me a few days ago? The skill of a physician might have saved her life, but for four days it was impossible to find in the district one who could attend civilian patients. When at last one was able to come, it was too late.

A. F. JENNINGS (MRS. SIDNEY J.), *Secretary.*

DIED IN SERVICE

Bailey, Lewis Newton, Master Engineer, Senior Grade, 4th Regiment, U. S. Engineers, Headquarters Company, died of pneumonia at Camp Merritt, N. J., on April 30, 1918.

Baird, Louis, Lieut., Royal Field Artillery, British Army, died on the battlefield in 1915.

Ballamy, John H., Capt., 103d Engineers, killed in action near Fismes, Aug. 9, 1918.

Burt, Andrew, died in active service, 1916.

Cobeldick, William Morley, Royal Engineers, died from gas poisoning on October 7, 1915.

Dougall, Ralph, 4th University Co., Princess Patricia Regiment, killed in action early in the war.

Evans, Alfred Winter, Lieut.-Col., New Zealand Rifle Brigade, D. S. O., D. C. M., killed in action on October 12, 1917.

Gorman, Thomas C., Lieut., Canadian Engineers, killed in France, Mar. 18, 1918.

Hague, William, 1st Lieut., Engineer Officers' Reserve Corps, died in active service, Jan. 1, 1918.

Hall, William T., Capt., Royal Flying Corps, killed in action, May 19, 1917.

Heine, Bernhardt E., Lieut., Aviation Service, died from accident at Fort Sill, Okla., Aug. 10, 1918.

Irving, John Duer, Capt., 11th Engineers, A. E. F., died July 26, 1918, while on active service in France.

Perry, Edward H., 1st Lieut., Co. D, 6th Regiment Engineers, U. S. Expeditionary Forces, France, killed in action on March 30, 1918.

Pretyman, Frank Remington, 2d Lieut., Royal Engineers, killed in action on June 17, 1916.

Reece, Fred. B., Capt., Royal Engineers, B. E. F., 232d Army Troops Co., killed in action.

Ringlund, Soren, Medical Department, Fort Logan, Colo., died suddenly in camp on July 24, 1918.

Roper, George, Jr., Lieut., Royal Flying Corps, killed in aeroplane accident in England on May 25, 1918.

IN MEMORIAM

CAPTAIN JOHN H. BALLAMY

John H. Ballamy, Captain on the Regimental Staff of the 103d Engineers, was killed near Fismes, on August 9, 1918.

Captain Ballamy was born at Plymouth, Pa., in 1886 and graduated from the High School of that town in 1903. In the following year he began work as a coal miner, and at the same time began the study of mining engineering in the evening and any other spare time. He continued this diligent and energetic practice for many years. For sixteen years he continued in the employment of the Delaware, Lackawanna & Western Railroad Company's coal mining department, first as a practical miner, next as rodman on the survey corps, of which he soon became chief, then draftsman and mining engineer in the company's office. In January, 1916, he was promoted to the position of district engineer in charge of mining engineering work. He became a member of this Institute in September, 1917.

CAPTAIN JOHN H. BALLAMY.

Captain Ballamy's military experience began at the same time as his engineering practice. He was a charter member of Company A, Engineers, N. G. P., which was organized ten years ago. He saw service on the Mexican border as First Lieutenant of this Company, and remained in that position until November, 1916. In July, 1917, he was again called into service and was sent to Camp Hancock, Ga., with the 103d Regiment of Engineers. Before joining this regiment he attended a school for officers at Fort Sill, Okla., where he received special training in field fortifications. In December, 1917, he was commissioned Topographical Captain on the Regimental Staff, and in April, 1918, preceded his regiment by about six weeks to France, where he again attended an officers' training school. He rejoined his regiment on July 15, near Chateau Thierry and was killed near Fismes on August 9, 1918.

LIEUTENANT THOMAS CLARENCE GORMAN

Since the publication of the brief biographical notice of Lieut. Gorman in the October *Bulletin*, we have received the following additional information from his mother, in Los Angeles, Cal.

After graduating from McGill University in 1913, Mr. Gorman spent several months in a tour of Europe. On returning to Canada, he was engaged successively by the Dome Mining Co., at South Porcupine, and at the Creighton mine, Ontario, where he was employed at the time of enlisting for service. He went to France in March, 1916, and was connected with the 2d Canadian Tunnelling Company.

He was killed by a bursting shell on March 18, 1918.

A letter written by Major Ritchie, commanding the 2d Tunnelling Company, to Lieut. Gorman's mother, contains the following words.

LIEUTENANT T. CLARENCE GORMAN.

Tommy was killed at our headquarters by a nine-inch shell which struck the officers' quarters. The Hun had been shelling a small village close to the camp with a long-range gun and a shot fell into our camp Tom was killed instantly by the concussion. He was buried this morning with Military Honours in the military cemetery close to our camp. Tommy was an efficient officer and a good soldier and his loss is very keenly felt by the officers and men of this unit.

NEWS FROM MEMBERS IN SERVICE

Lieut. Louis J. Brunel, now in France, was commissioned on July 27, 1917, as Second Lieutenant in the Engineers Reserve Corps, assigned to the 7th U. S. Engineers, Dec. 10, 1917, and has been with the American E. F. since Mar. 26, 1918. He was assigned to the staff of the General commanding the 5th Field Artillery Brigade, as Engineer Officer, on Aug. 6, 1918.

E. Ross Housholder writes that "the record for pontoon bridge building was broken Sept. 25, 1918, by Section A, Co. 4, 5th Engineer Officers' Training School, at Camp Humphreys, Va., of which I am a member. The time was 15 min. $11\frac{3}{5}$ seconds. We then proceeded to break the record for dismantling in 9 min. $57\frac{1}{5}$ seconds. The length of the bridge section was 200 ft. The post band was sent out to meet us, and we feel proud of this record. I have met quite a few A. I. M. E.

men in camp here. F. H. Geib, a junior member of the Institute, is in Co. 2, E. O. T. S., and has been recommended for a commission."

Charles J. Millard, Capt., 12th Engrs., A. E. F., writes us an interesting letter from the front in which he says "I hope this war won't last long; but cannot very well see the end for at least three years more. July 10th of this year makes one year in active service, July 28th saw the completion of one year's service in France.

"We have been busy ever since arriving last year. Our first work, as you know, was with the British. We all wish we could be with the British now to advance over the country that witnessed our retreat in March. At that time Hell sort of broke loose, but before this war is over the confines of that particular kingdom are going to be very definitely defined. The United States will well be proud to have saved the day.

"You have heard how the 'Ladies of Hell' and the Australians and Canadians fight? You should hear how many of our boys can outshine them (and that is going some)."

W. Clifford Rehfuss, Ensign, U. S. N. R. F., says "On Nov. 1, 1917, I left Philadelphia as a Second Lieutenant in the Russian Railway Service Corps which was sent to Russia at that time to improve conditions on the Trans-Siberian Railway. Owing to the great upheaval that was passing through Russia at the time we arrived in Vladivostock, we were ordered to Japan to await orders, and remained there for three months. About the beginning of April, orders came to proceed home, and, after some delay due to the great difficulty in obtaining transportation, we arrived in Philadelphia about the 10th of May. Shortly afterward the contingent was disbanded and I was transferred to the Naval Reserve Force with a commission as Ensign, being enrolled under the class of technicists. On receiving my orders, I proceeded to the Naval Proving Grounds at Indian Head, where I am still stationed."

Capt. A. H. Ryder is at present with the Egyptian Expeditionary Force in Arabia. He regrets to say that he does not come much in contact with mining men, but wishes he did. Capt. Ryder has been in Arabia since January, 1917, and expects to get leave to England very soon.

E. A. Smith was Captain with the Royal Engineers during the period of 1915–16 when an attack of the Turkish forces on Egypt was expected. On their retreat, he applied to return to his work as General Manager of the Sinai Mining Co. Although he is not, therefore, directly working for the Government, the product of the mines—manganiferous ore—is urgently needed for munition purposes.

Capt. Hugh M. Steven writes from France:

"I am located with the 7th Battalion Canadian Engineers, France. Most of the mining engineers of Canada were with one of the three Canadian tunnelling companies, but in July of this year they were broken up and amalgamated with other engineering units, to form engineering battalions, one being allotted to each of the 12 active Canadian Brigades. The days of old front line offensive and defensive mining are for the present at an end, and the likelihood of their resurrection is small with the Allies constantly on the advance. We are being used on demolition work, reconnaissance of captured enemy underground dugout systems, construction of roads and bridges, and general engineering work of that nature.

"I left the Hollinger Consolidated in the early Spring of 1916 and arrived at the Ypres salient on July 15, being posted to the 1st Canadian

Tunnelling Company, with which unit I remained until this recent reorganization of forces came into effect."

Major J. W. Teale joined the Forces in October, 1914. In May, 1915, he was sent to Gallipoli, having been promoted to the rank of Major before his departure. His regiment was the Royal Naval Divisional Engineers. Major Teale remained in Gallipoli until the evacuation at the beginning of 1916, and for his services there, and particularly those at the time of the evacuation in the destroying of stores, etc., and the construction of embarkation piers, he was awarded the D. S. O. While in Gallipoli, Major Teale was made Bombing Officer to the 8th Army Corps; the bombing operations of this Corps are particularly mentioned in a despatch of General Monro's.

Major Teale returned to England in March, 1916; since then, he has been transferred to the Royal Engineers and made D. O. R. E. at an English camp, where there were also German prisoners.

ADDITIONAL LIST OF MEMBERS OF THE INSTITUTE IN MILITARY SERVICE

(The following list contains the names of those members of the Institute of whose connection with military service we have only recently become acquainted; it also includes the names of a few who have recently been promoted or transferred, indicated by a *. A complete list was published in the Year Book, issued as a supplement of the *Bulletin* for March, 1918.)

ALLEN, ROY H., Capt., Air Service, Bureau of Aircraft Production, Washington, D. C.

*AMIDON, CLAUDE E., Chemical Warfare Section, Astoria, L. I.

*ARCHBALD, HUGH, 311th Infantry, 78th Division, American E. F.

ASKIN, THOMAS B. H., Radio Station, Cavite, P. I.

*AYER, FRANK A., Lieut., Commanding Officer, 270th Aero Squadron, American E. F.

BARBA, W. P., Lieut. Colonel, Ordnance, U. S. A., Washington, D. C.

*BARRETT, LESLIE P., 1st Lieut., 5th Field Artillery, American E. F.

BLICKENSDERFER, F. C., 1st Lieut., N. A., Ordnance Dept., Edgewood Arsenal, Edgewood, Md.

*BROOKS, FLOYD R., Lieut., Canadian Engineers, Seaford, England.

BROWN, GEORGE M., Co. G, 1st Replacement Regiment, Washington Barracks, D. C.

*BRUNEL, LOUIS J., Lieut., 5th Field Artillery, Brigade Headquarters, American E. F.

*BRUNTON, D. W., Cons. Engr., Naval Consulting Board, Washington, D. C.

BULL, R. A., Capt., Ordnance Reserve Corps, Rock Island Arsenal, Ill.

CALLAWAY, F. W., Corp., Miners & Sappers School, U. S. M. C., Quantico, Va.

CARLISLE, STANLEY B., Co. A, 346 M. G. Bn. A. P. O. 776, American E. F.

CARSON, JOSEPH A., Capt., A. S., S. R. C.

*CHAPMAN, LEWIS C., 29th Engineers, A. P. O. 714, American E. F., France.

*CHASE, J. L., Cadet No. 2011205, Canadian Engineers Training Depot, St. Johns, P. Q., Canada.

CHATIN, AUGUST H., 472d Engineers, U. S. A., Washington, D. C.

*COULDREY, P. S., 313134 W. R. No. 5 Works Co., Saltpans near Sandwich, Kent, England.

CRAGIN, RODNEY S., Co. E, 115th Engineers, Camp Kearny, Cal.

CROWDUS, JOHN WILLIAM, 1st Lieut., Engineers Corps, U. S. A.

DALE, RALPH, Lieut., Co. E, 114th Engineers, American E. F.

DENNIS, PAUL J., 115th Engineers, Camp Kearny, Cal.

DOVE, D. R., Candidate, 21st Training Battery, F. A. C. O. T. 6, Camp Zachary Taylor, Ky.

DUNBAR, D. M., Co. 20, 5th Battery, 163d Depot Brigade, Camp Dodge, Ia.

EULICH, A. V., Pvt., Co. H., 2d Engineers Training Regiment, Camp Humphreys, Va.

FESSENDEN, JOHN H., JR., Electrician 2d Class (Radio), U. S. N. R. F.

FRITH, CHARLES WILLIAM, 3d Co., Coast Artillery Corps, San Pedro, Cal.

*GARRISON, MURRAY E., Flying Cadet, Squadron No 1, Camp Dick, Dallas, Tex.

GEIB, FRANCIS H., Co. 2, E. O. T. S., Camp Humphreys, Va.

GOODWIN, EDWARD H., Aviation Corps, Barracks No. 1, Champaign, Ill.

*GORELANGTON, C., Capt., Co. 4, E. O. T. S., Camp Humphreys, Va.

GOTSCH, OSCAR, JR., Chief Machinist's Mate, U. S. Navy Steam Engineering School, Stevens Institute, Hoboken, N. J.

*GREEN, WALDRON A., 2d Lieut., Co. D, 27th Engineers, American E. F.

GRENFELL, DONALD S., 121 Ambulance Co., 106th Sanitary Train, Camp Wheeler, Ga.

GRIGGS, C. C., Major, Ordnance Dept., U. S. A.

HAMPTON, WILLIAM H., Gas Defense Div., Chemical Warfare Service, U. S. A., Long Island City, N. Y.

*HARMS, P. L., Major, 19th U. S. Infantry, 18th Division, Camp Travis, Tex.

*HOUSHOLDER, E. ROSS, Co. 4, E. O. T. S., Camp Humphreys, Va.

HUTCHINS, R. GROSVENOR, JR., Head, Bureau of Home & Hospital Service, American Red Cross, France.

*IRWIN, J. S., 2d Lieut., Infantry, U. S. A., Camp Perry, O.

JONES, WENDELL T., Co. D, 316th Engineers, American E. F., France.

KROEGER, A. C., Co. 1-b, E. O. T. S., Camp Humphreys, Va.

LAROQUE, F., Cadet, Royal Air Force.

LEVY, MILTON M., 1st Lieut., Co. 8, C. A. C., Fort Rosecrans, Cal.

LIVERMORE, ROBERT, 2d Co., Engr. Officers' Training School, Camp Humphreys, Va.

*LOERPABEL, W. HARRISON, Co. 5, E. O. T. S., Camp Humphreys, Va.

LUNT, HORACE E., Capt., Engineer Officers' Training Camp, Camp Humphreys, Va.

LYON, GEORGE J., Capt., Engineers, Construction Division of the Quartermaster Warehouse, Schenectady, N. Y.

MCCLOSKEY, DOWNS, Lieut., 2d Regiment, 1st Brigade, Camp Jackson, S. C.

MCCRORKEN, EUGENE P., U. S. Navy.

MACKEY, R. W., 1st Lieut., Engineers, U. S. A.

MACNICHOL, A. W., Ensign, U. S. N., U. S. S. Pastores, care Postmaster, N. Y.

MARSH, A. G., Corp., Co. C, 18th Railway Engineers, American E. F., France.

MARTIN, CURTIS F., Co. B, 27th Engineers, American E. F.

*MEANS, A. H., 2d Lieut., F. A., N. A., 314th Field Artillery, 55th Art. Brigade, American E. F.

*MEGRAW, H. A., Bureau of Aircraft Production, Washington, D. C.

MEISSNER, C. E., 27th Engineers, Sgt., Co. B.

*MILLER, W. B., 2d Lieut., Co. B, 1st Gas Regiment, A. P. O. 706, American E. F., France.

*MOGA, JOHN A., Student, Officers' Training School, Fort Monroe, Va.

*MURRAY, MALCOLM S., Co. C, 98th Engineers, Camp Leach, D. C.

NIGHMAN, C. E., 1st Lieut., Air Service (Aircraft Production).

PALMER, W. F., Co. D, 1st Replacement Regiment, Washington Barracks, D. C.

REED, A. SCOTT, Lieut., Seaforth Highlanders, Attached 1st Garrison Battalion, The Royal Scots, Egyptian E. F.

*REED, WILLIAM, Lieut., H. Q. Special Co., R. E., Second Army. Military Cross, June, 1918.

*REHFUSS, W. CLIFFORD, Ensign, U. S. N. R. F., Naval Proving Ground, Indian Head, Md.

*RODEGERDTS, C.A., Ensign, U. S. Navy Aviation.

ROGER, EUGENE, French Army.

*RYDER, ALFRED H., Capt., Royal Engineers, Egyptian E. F.

*SCHINDLER, DONALD F., Co. 5, E. O. T. S., Camp Humphreys, Va.

SCHMIDT, ROBERT DROEGE, Lieut., 324 F. A. H., American E. F., France.

SEARS, STANLEY C., Capt., Engineers, U. S. Army, Camp Humphreys, Va.

*SHAYES, F. P., Lieut., Aviation Section, American E. F.

STEINEM, CHESTER, 2d Lieut., Heavy Coast Artillery, Fort Monroe, Va.

STEPHENSON, GRANT T., Senior Lieut., U. S. N. R. F.

*STUART, C. E., Capt., Staff College, American E. F.

*SULLIVAN, CLARKE, Capt., Co. A, 209th Engineers, Camp Sheridan, Ala.

TEAS, PIERSON, 2d Lieut., O. M. C. S., Camp Raritan, Metuchen, N. J.

THOMPSON, EDWARD C., Capt., Chemical Warfare Section, Edgewood Arsenal, Edgewood, Md.

THOMPSON, LESTER S., Co. C, 29th Engineers, American E. F.

*WAITE, ALLAN G., 1st Lieut., Air Service, Military Aeronautics, U. S. A.

*WARD, A. T., 5th Prov. Co., Casual Detachment, Camp Wadsworth, S. C.

*WILLIAMS, CHARLES F., 2d Lieut., Co. D, 30th Gas Regiment, American E. F.

*WILLIAMS, RALPH O., 2d Lieut., Co. 1, 319th Infantry, A. P. O. 756, American E. F.

WILSON, HARRY R., 32d Training Battery, F. A. C. O. T. S., Camp Taylor, Ky.

*WITT, HERBERT N., U. S. N. R. F., Officers' Material School, Mare Island, Cal.

*WOLVERTON, F. M., Acting Corporal.

ENGINEERING COUNCIL

REORGANIZING AMERICAN ENGINEERS

There are in America approximately 500 engineers' organizations of various kinds, and yet it is estimated in many communities that 30 to 50 per cent. of the resident engineers are not members of any society of engineers. There is no enumeration of the engineers of the country, but estimates range from 100,000 to 300,000, the latter number probably including assistants, such as instrumentmen, draftsmen and inspectors, together with professional engineers. These local, state, regional and national organizations are for the most part independent and have no means for coöperation.

Steps toward the improvement of these conditions are being taken in a number of localities and have already been taken in others. Many engineers are giving the matter serious attention. American Society of Civil Engineers took an important action at the June meeting of its Board of Direction, by authorizing the creation of a Committee on Development of Am. Soc. C. E. This action is now well known to all representatives on Engineering Council. Other Founder Societies are reported to be considering similar action.

Engineering Foundation, at its meeting on Sept. 12, adopted the following resolutions:

Survey of Engineering Organizations

BE IT RESOLVED: that the Engineering Foundation is prepared, the four Founder Societies concurring, to devote its strength and its income, so far as this may be required, to a study of existing engineering organizations, and from information thus developed to formulate a series of constructive recommendations which may be serviceable in guiding the further development of local and national engineering organizations in their relations to the profession of engineering, to the public and to each other, to the end that a foundation may be laid upon which to establish a broadly planned procedure, which, while recognizing and preserving all that has already been accomplished, shall increase the power of American engineers in upbuilding their profession and in the service they render to society; and

RESOLVED: that in accepting the responsibility for such an undertaking, it will be the purpose of the Engineering Foundation to organize the proposed research along the broadest possible lines, to call to its aid highly qualified experts, and to avail itself of the help of agencies which may be willing to coöperate; and

RESOLVED: that in proposing this research the Engineering Foundation has no desire or purpose to intrude upon the domain of individual organizations; that it does not propose to control the action of any individual or organization; nor to ask the acceptance of its conclusions; but that its purpose shall be to develop a possible procedure, or a series of such procedures, of such evident merit that they will appeal to those who are likely to be most interested; it will do this in the belief that in so far as its work may justify the confidence of engineers and of engineering organizations, it will bear its own fruitage.

What will Engineering Council do? Many engineers throughout the country are looking to it for leadership. Others frankly say that no large help can come from the Council because of the way it is organized and the restriction on its membership which excludes all but national societies; provisions must be made for direct connection with the important local groups of engineers. The questions raised are: Can Engineering Council meet the needs for coöperation now felt among American Engineers? Will Engineering Council do something now? The solution of the problem of more effective organization of engineers will be worked out. Will Engineering Council be a leader in progress toward the goal, coöperating with other agencies?

WAR COMMITTEE OF TECHNICAL SOCIETIES

The following written report was presented at a stated meeting of Engineering Council, on Sept. 19, 1918.

Soon after our last report to the Council the necessity for a closer contact with the different branches of the Army and Navy became so apparent that the Chairman of the Committee has spent most of his time in Washington on this work. As all problems relating to war inventions are issued from the War Department in Washington, and as solutions of problems, as well as ideas, suggestions and inventions must be presented there for consideration and acceptance, it is manifest that our Committee, in order to receive ready consideration, must be on the spot, which, of course, means a Washington office.

Recently the Inventions Section of the General Staff, in recognition of the work which the War Committee is carrying on, offered, if the War Committee would open an office in Washington, to appoint a Liaison Officer who would have special charge of the work and the relations between the Committee and the Army. After consultation with the different members of the Committee, this most advantageous offer was accepted, and at the last meeting of the War Committee the following resolution was unanimously adopted.

RESOLVED: that while continuing an office of the War Committee in New York, an office shall also be established in Washington, and the Secretary is authorized to move to Washington such furniture as can be spared from the New York office. This action is subject to the approval of the Engineering Council, who are to be given a full explanation of the reasons for it.

The Naval Consulting Board has recently established offices in Washington and has arranged to share them with the War Committee, without expense for rental, heat, light and telephone.

The General Staff has appointed one of its officers, Captain Lloyd M. Scott, a mining engineer by profession, to the War Committee as Liaison Officer, and the War Committee has made Captain Scott its Secretary.

The establishment of an office in Washington will in no way interfere with the operation of the New York office, which will remain in its present quarters in charge of Edmund B. Kirby, Vice-chairman, as it has been since last June. Committee meetings will be held in New York as before, the Chairman or Secretary coming up from Washington for the purpose.

Due to rigid economy on the one hand and the generosity of the Naval Consulting Board on the other, the expenses of the War Committee have been held down to about one-half of the appropriation granted it by the Engineering Council. The establishment of an office in Washington will add but little to the present expenses, and an appropriation of $250 per month will be ample for our requirements. If, however, some means could be devised whereby the War Committee had at its disposal $2500 per month, its usefulness could be greatly increased, as it could then put out its own bulletins, hold public meetings, and adopt many other ways of bringing the requirements of the Government before its members. Unfortunately, there does not seem to be any middle ground, and if we cannot obtain the larger appropriation we shall have to be content with the smaller, and depend on the assistance of the Army and Navy for bulletins, problems, and general publicity work.

SPOKANE ENGINEERING AND TECHNICAL ASSOCIATION

From L. K. Armstrong, Secretary of the Columbia Section of the Institute, we have received information as to the activities and plan of the Spokane Engineering and Technical Association, which was recently organized under the joint auspices of the local sections of the American Institute of Electrical Engineers, the American Society of Civil Engineers, and our own Institute.

The first meeting was held on September 20, at which a program for the following year was adopted. The meeting was then conducted by the Civil Engineers, the principal business being the reading of a report by Mr. Flinn, Secretary of the United Engineering Society.

The second meeting was held on October 18, of which the Columbia Section of our Institute took charge.

According to the program adopted, meetings will be held regularly on the third Friday of each month, except June, July and August. It is understood that these meetings shall not interfere with nor abridge the independent activity of the participating societies. The proposed work of the Association is to be conducted by a large number of committees, whose attention will be devoted to such subjects as the following: Municipal, Highways, Resources, Manufacture and Industries, Legislative, Educational, National and State, Patents and Inventions, Americanization, Safety and Rehabilitation, Research, Emergency. When all of these committees shall have been filled, and their work begun, it is expected that the engineers of Spokane and vicinity may take a more active part in things affecting human welfare in that vicinity.

DELAYS IN PUBLICATION

In explanation of the delay, which may have been noted by members of the Institute, which has affected both the *Bulletin* and Volume 59 of the *Transactions*, we may mention that our printers, in common with nearly all publishing concerns in the country, have recently been overwhelmed with work on text books and similar technical matter required in connection with the education of the student-army recently inaugurated by the Federal Government. Although we regret the delay in the issuing of our periodical, we cannot help feeling that our publications are perhaps second in importance to the needs of the army. It is to be hoped that the present excessive demand for printing of this sort will soon be passed, after which we shall resume publication with more punctuality.

PERSONAL

The following is an incomplete list of members and guests who called at Institute headquarters during the period Sept. 10, 1918 to Oct. 10, 1918.

Thomas J. Adams, Rahway, N. J.
Henry M. Ami, Washington, D. C.
Chester Atkinson, Peru, South America.
Bennett R. Bates, Berkeley, Cal.
Robert S. Botsford, Petrograd, Russia.
Juan Felix Brandes, Santa Barbara, Cal.
G. A. Collins, Seattle, Wash.
C. V. Corless, Coniston, Ont., Canada.
F. T. Eddingfield, Washington, D. C.
C. Mason Farnham, Barre Plains, Mass.
F. N. Flynn, Trail, B. C., Canada.
Duncan D. Forbes, Humboldt, Ariz.
Alexandre Gouvy, Paris, France.
Henry G. Granger, Cartagena, Colombia, So. Amer.
E. Harms, El Paso, Tex.
Alfred G. Heggem, Tulsa, Okla.
H. B. Henegar, Mascot, Tenn.
A. M. Kivari, Denver, Colo.
T. M. Kniffin, Brookline, Mass.
Charles Lehman, London, England.
Donald H. McLaughlin, Camp Meade, Md.
A. N. Mackay, London, England.
A. W. MacNichol, San Francisco, Cal.
Ernest Marquardt, Casper, Wyo.
Lieut. S. A. Mewhirter, Denver, Colo.
William A. Nelson, Nashville, Tenn.
Robert W. Olinger, Bahia, Brazil, So. Amer.
G. Preumont, La Paz, Bolivia, So. Amer.
William H. Rettie, Yonkers, N. Y.
Julius Segall, Minneapolis, Minn.
Robert Y. Seip, Franklin, N. J.
H. M. Schleicher, Boston, Mass.
Chester Steinem, Ft. Monroe, Va.
A. L. Sweetser, Pittsburgh, Pa.
H. E. Treichler, Creighton Mine, Ont., Canada.
Frank A. W. Tullock, Yumbo, Colombia, So. Amer.
Edward I. Williams, Ft. Monroe, Va.
Alfred W. G. Wilson, Ottawa, Canada.

C. E. Addams, who recently resigned as general manager for the Arizona Hercules Copper Co., has leased the Ray silver-lead property three miles from Ray, Ariz.

Bennett R. Bates has resigned his position as general superintendent of the Cubo Mining & Milling Co., in order that he may take the examination for an officer of engineers.

S. H. Brockunier, formerly on the staff of the *Engineering & Mining Journal*, has accepted the position of superintendent at the Chateaugay Ore & Iron Co., of Lyon Mountain, N. Y.

F. W. Bunyan has resigned his position with the Southern Pacific Railway Co., and accepted the position of assistant chemist with the Noble Electric Steel Co., of Heroult, Shasta Co., Cal., engaged in the manufacture and supply of ferrous alloys for the Pacific Coast.

Captain Maurice Cockerell has succeeded Sir Lionel Phillips as Director of the Department for the Development of Mineral Resources in the Ministry of Munitions, England.

William M. Corse, general manager of the Titanium Bronze Co., Niagara Falls, N. Y., has resigned to become associated with the Ohio Brass Co., at Mansfield, Ohio. Mr. Corse is a brass foundryman and metallurgist of wide experience. He was elected secretary-treasurer of the American Institute of Metals in 1908 and president in 1917. This organization now constitutes the Institute of Metals Division of the American Institute of Mining Engineers.

Prof. C. L. Dake, of the department of geology of the Missouri School of Mines, has just returned to his duties, after a year's leave of absence spent in consulting work with the firm of Valerius, McNutt, and Hughes, Petroleum Geologists, of Tulsa, Okla.

J. H. Dietz has accepted a position with the American Zinc Products Co., of Greencastle, Ind.

Frank T. Eddingfield is now occupying the position of mining engineer with the Bureau of Mines, Washington, D. C.

Claude Ferguson announces that he has resigned his position as superintendent for the Copper Queen Gold Mining Co. to accept a similar position with the Consolidated Arizona Smelting Co., in charge of the DeSoto and Swastika mines. His new address is Ocotillo, Ariz.

C. A. Filteau, of the National Mines, Ltd., Cobalt, Ont., has been appointed manager of the flotation plant of the Peterson Lake Silver Cobalt Mining Co., at Cobalt.

John A. Fulton, of Melones, Cal., announces the birth of a son on Sept. 15, 1918.

Robert George Hall, formerly general manager of the River Smelting & Refining Co., of St. Louis, Mo., is now resident manager of the Burma Mines Limited, Namtu, Upper Shan States, Burma.

William H. Hampton has been placed in charge of investigation and development of miscellaneous gas defense apparatus, Gas Defense Division under Major Waldemar Kops, Chemical Warfare Service, U. S. A., at Long Island City, N. Y.

D. Harrington, formerly at the Montana State School of Mines, is now mining engineer with the U. S. Bureau of Mines, at Golden, Colo.

O. F. Heizer is Superintendent of the Sheepranch mines, Sheepranch, Cal.

J. C. Houston, formerly assistant manager of the Dome Mines, Ltd., at Porcupine, Ont., has been appointed manager of the Kirkland-Porphyry gold mine.

A. G. Kirby is now general manager of the Darwin Lead & Silver Mines & Dev. Corpn., at Salt Lake City, Utah.

Oscar Lachmund has resigned as general manager of the Canada Copper Corporation and will be succeeded by Hugh R. Van Wagenen, of Denver, Colo. Mr. Van Wagenen has been in British Columbia looking over the situation and is to return to take up his new duties in a few weeks.

Richard G. Place has resigned his position as chief chemist of the Vermont Copper Co., at South Strafford, Vt., to accept a position with the Golden Age Mining & Reduction Co., at Boulder, Colo.

W. J. Priestley has tendered his resignation as division superintendent of forges, foundries and machine shops of the Bethlehem Steel Co., to take effect at once.

M. F. Sayre has been appointed Assistant Professor of Applied Mechanics in Union College, Schenectady, N. Y.

A. G. Suydam has opened an office in San Francisco for consulting work.

H. E. Treichler, formerly with the Canadian Copper Co., has accepted a position with the Gulf Sulphur Co., at Matagorda, Tex.

Carlos W. VanLaw announces his resignation as a Vice-president from the staff of the United States Smelting, Refining & Mining Co. He will engage in a general consulting practice.

I. **Edmund Waechter** resigned his position of chief chemist and metallurgist with the Standard Tool Co., Cleveland, on Apr. 30, 1918. From that date until October 1, he was melter on a Heroult electric furnace and chemist for the Crucible Steel Casting Co., Cleveland, Ohio. He has now accepted a position on the chemical staff of the Carnegie Steel Co., Youngstown District, as chemist and metallurgist.

H. Vincent Wallace, consulting mining engineer, has opened an office at 329 Central Bldg., Los Angeles, Cal.

A. P. Watt has recently received his appointment from Washington as consulting mining engineer to the Bureau of Mines. His special work at present will be in reference to the concentration of pyrite, for the production of sulphuric acid.

Bulkeley Wells, Governor of the Colorado chapter of the American Mining Congress, has been elected a member of the national board of directors of the congress.

Gordon Wilson is leaving Arizona for Fresnillo, Zac., Mexico, to take the position of mill and cyanide superintendent of the Fresnillo Co.

Ernest Leon Swift Wrampelmeier has changed his name to Ernest Lee Swift, by an order of the court granting such change to him and relatives. He is a Life Member of the Institute.

Ira L. Wright has opened a mine engineering office in Silver City, N. M.

POSITIONS VACANT

No. 347.—A South African development company will shortly require the services of a mill superintendent, who has a general knowledge of concentration, particularly of flotation, and is able to take charge of a copper concentrator treating 15,000 tons per month and employing 200 natives and a small number of white men.

Salary is £60 per month to start, and the company supplies an unfurnished room or house, including free light, free water and free sanitary service, together with one native house servant. A contract will be made for 6 months, and notice of 3 months by either party will be required to terminate the engagement after 6 months. An allowance of £75 for traveling expenses will be paid on arrival in South Africa to a single man, or £125 to a man who brings his family. Salary begins upon arrival in South Africa, and no allowance will be made for return traveling expenses.

No. 349.—A Canadian university wishes to engage a man to teach non-ferrous metallurgy and ore-dressing as well as to direct research work. The instruction work covers 7 months but the research work is continued throughout the year. To a suitable man the rank of professor will be granted. Applicants are requested to state education, experience, salary desired and any other particulars that might assist in selecting a man for this position.

No. 350.—Wanted, 60 engineers for ordnance training school, month's training. Salary for first three months $1200 to $1500. After 3 months, up to $2400.

No. 351.—A prominent Bolivian tin miner requires the services of two engineers in Bolivia—the one to act as assistant to his present general manager, who will turn over to him the actual duties of the mine; the other to act in the special capacity for conducting the exploitation work at another one of his properties. Both properties are already well known and have the usual accommodations of such localities and are within easy range of Oruro. It will be necessary for the applicant to have some knowledge of Spanish and be sufficiently able to demonstrate physical ability to withstand the altitude which ranges from 12,000 to 15,000 ft.

No. 352.—Mining assistant wanted by concern in Peru, on important silver-lead mines at altitude of 16,000 ft. Must be competent assayer and with good experience in timbering of heavy ground. Apply, stating experience, age, nationality, salary expected, with copies of credentials.

No. 353.—Engineer desired, preferably young man who is exempt from draft. Recent graduate would be satisfactory, although experience of a year or two would be preferred provided salary requested was not too high.

ENGINEERS AVAILABLE

(Under this heading will be published notes sent to the Secretary of the Institute by members or other persons introduced by members.)

No. 488.—Mining engineer, member, technical graduate, married, age 38, desires position of superintendent or assistant superintendent. Has had 15 years' practical experience as miner, millman, machinist, surveyor, engineer, foreman, and superintendent in the West, Southwest, and Mexico. Speaks Spanish. Now employed as superintendent of copper property in Southwest. Can give the best of references. Minimum salary $250. Available now.

No. 491.—Mining engineer, member, married, age 43, desires to connect with some good coal company as superintendent or manager. Is thoroughly conversant with flat and pitching systems of coal mining. Has had 23 years experience from the bottom up; 7 years experience as superintendent and manager. Good organizer. Has handled all classes of labor and has always made good. Available now.

No. 492.—Metallurgist and chemical engineer, member, with 8 years executive experience in research and technical direction of all departments of non-ferrous metallurgical manufacturing, is open for change in position. Specialist in raw materials and supplies, reclamation of wastes, and standardized control of processes.

No. 493.—Member, age 37, technical education, married. Seventeen years' experience as superintendent, engineer, chemist and assayer, exploration engineer in United States, Central and South America, Siberia and India. Especially in iron, manganese, copper, and rare metals. Desires to make a change.

No. 494.—Electrometallurgical engineer, member, age 30, A. M. and Ch. E. degrees, thoroughly trained in electrochemistry, metallurgy and electrometallurgy. Three years in charge of experimental work on and operations of electric furnaces. Desires responsible position in investigative or executive work with commensurate salary.

No. 495.—Member, age 36, married, technical, 10 years all round experience operation and examination gold, silver, copper, manganese, in United States, Mexico, South America. At present in States. Desires change of position.

No. 496.—Member, married, age 36; technical training; 8 years practical experience; 3 years as head executive of large coal operation. Open for engagement.

No. 497.—Member, age 34, married, technical graduate, 10 years experience as engineer and superintendent of copper and lead mines and mills. Experienced in the hydrometallurgy of copper ores, and in construction work; good mechanical sense.

No. 499.—American mining geologist and engineer 41 years old will be open for engagement about Dec. 1. Experienced in Eastern American geology, including West Indies; especially iron ores and ferro-alloy minerals, pyrite and chemical minerals. Has been a producer of high-grade concentrates.

No. 500.—Mining and metallurgical engineer, graduate of Mining Academy of Petrograd, Russia, age 38. Speaks English, French, Russian, reads Swedish and Spanish, desires position. References.

No. 501.—Member, age 30, married, desires to change position. Experience covers laboratory, engineering department and plant operation in zinc smelter and lead refinery.

LIBRARY

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF MINING ENGINEERS
UNITED ENGINEERING SOCIETY

HARRISON W. CRAVER, DIRECTOR

The library of the above-named Societies is open from 9 A. M. to 10 P. M. except on holidays. It contains about 70,000 volumes and 90,000 pamphlets, including sets of technical periodicals and publications of scientific and technical societies.

Members of the Institute, with few exceptions, are forced to spend a portion of their time in localities isolated from sources of information. To these the Library, through its Library Service Bureau, can render valuable service through correspondence; letters requesting information will receive especial attention. The Library is prepared to furnish references and photographic copies of articles on mining and metallurgical subjects; to determine the existence of mining maps, and to furnish general information on the geology and mineral resources of all countries.

All communications should be made as definite as possible so that the information received may be what is desired and not include collateral matter which may not be of interest. The time spent in searching for such collateral matter will be saved, and the information will be sent more promptly and in more usable shape.

Library Accessions

Aciers fers, fontes. Tome I. By Alexis Jacquet. Paris, 1918.

Bangor Mineral District. (Tasmania Geological Survey. Bulletin No. 27.) Tasmania, 1918.

Calcul des systèmes élastiques de la construction. By Ernest Flamard. Paris, 1918.

L'Electrochimie et L'Electrométallurgie. By Albert Levasseur. Paris, 1917.

From the Falls to the Factory; a treatise on electric power transmission. London, British Aluminum Company. (Gift of A. S. M. E.)

Formations Géologiques Aurifères de l'Afrique du Sud. By René de Bonand. Paris, 1917.

Gravity and temperature tables for mineral oils from determinations of the Bureau of Standards, and other tables for general testing and refinery practice. Compiled and Edited by E. N. Hurlburt. Rochester, 1918. (Gift of Taylor Instrument Co.)

Society of Automotive Engineers. Data sheets of Steel Specifications. (From the Seventh Report of the Iron and Steel Division adopted by the Society, Aug., 1915.) (Gift of Society of Automotive Engineers.)

Tin Field of North Dundas. (Tasmania Geological Survey. Bulletin No. 26.) Tasmania, 1918.

Book Notices

Unless otherwise specified, books in this list have been presented by the publishers. The Institute does not assume responsibility for any statements made; these are taken from the preface or the text of the book, unless otherwise noted.

CONCRETE STONE MANUFACTURE. By Harvey Whipple. Detroit, Concrete-cement Age Publishing Co., 1918. 318 pp., 82 illus., 104 pl., 7 × 5 in., cloth, $1.50.

A textbook for manufacturers of factory-made concrete units, based on the practice of various successful enterprises. Discusses plant layout, operation, methods, materials, finishing, building regulations, tests, etc.

GUIDE TO THE USE OF UNITED STATES GOVERNMENT PUBLICATIONS. By Edith E. Clarke. Boston, The Boston Book Co., 1918. 308 pp., 9 × 6 in., cloth, $2.50

A guide to the history, use, cataloging and classification of United States Government publications. Written primarily for librarians and library workers, it is broad enough in scope to serve as a laboratory manual for all who use the government publications inside libraries and out. Contains four bibliographies dealing with different phases of the subject.

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA. Giving Shipping Weights, Capacities, Outputs, and Net Prices of Machines and Apparatus, and Detailed Costs of Installation, Maintenance, Depreciation and Operation, together with Many Principles and Data relating to Engineering Economics. By Halbert P. Gillette and Richard T. Dana. 1st edition. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 17+1734 pp., illus., tab., 7 × 5 in., flexible cloth, $6.

This handbook is similar in method to the authors' two previous handbooks covering costs in the field of civil engineering and can be used to supplement them. It is almost entirely devoted to purely electrical and mechanical subjects. Chapters on general economic principles, depreciation, repairs and renewals are included.

A MANUAL OF ENGINEERING DRAWING FOR STUDENTS AND DRAFTSMEN. By Thomas E. French. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 12 + 329 pp., 556 illus., 9 × 6 in., cloth, $2.50.

A method of instruction, based upon the conception of drawing as a language, with varied forms of expression, a grammar and style. New chapters on lettering, screw threads, bolts and fastenings, and structural drawing have been added; the chapters on working drawings and architectural drawing have been enlarged, and the text generally revised.

THE METALLURGISTS' AND CHEMISTS' HANDBOOK. A Reference Book of Tables and Data for the Student and Metallurgist. Compiled by Donald M. Liddell. 2d ed., revised and enlarged. N. Y., McGraw-Hill Book Co., Inc., Lond. Hill Pub. Co., Ltd., 1918. 65 pp., illus., tab., 7 × 4 in., flexible cloth, $4.

A collection of tables and condensed data selected to include those most necessary to the chemist and metallurgist. Additions to this edition bear chiefly on war activities, such as alloys and toxic gases. A short chapter on organic chemistry is also included.

REINFORCED CONCRETE CONSTRUCTION. Part I. With Examples Worked Out in Detail for all Types of Beams, Floors and Columns. By M. T. Cantell. 2d edition. Lond., E. & F. N. Spon. Ltd., N. Y., Spon & Chamberlain, 1918. 160 pp., 75 illus., 1 pl., 7 × 5 in., cloth. (Gift of the author.)

The chief object in this work is to endeavor to meet the requirements of students, as well as others who have practical experience but only an elementary knowledge of mathematics and mechanics, for a simple practical treatment of the subject. Part I contains the principles, general information and examples of designing required by the majority of students and practical men. This edition is revised to comply as far as possible with American and Canadian, as well as British, conditions and practice.

FORTHCOMING MEETINGS OF SOCIETIES

Organization	Place	Date
		1918
National Society of Naval Architects	New York, N. Y.	Nov. 14–15
American Society of Mechanical Engineers	New York, N. Y.	Dec. 3–6
Geological Society of America	Boston, Mass.	Dec. 28–31
American Association for the Advancement of Science	Boston, Mass.	Dec. 27–Jan. 2.
		1919
American Society of Civil Engineers	New York, N. Y.	Jan. 15–16
American Wood Preservers Association	St. Louis, Mo.	Jan. 28–30
American Society of Heating and Ventilating Engineers	New York, N. Y.	Jan. 28–30
American Institute of Mining Engineers	New York, N. Y.	Feb. 17–20
New England Association of Gas Engineers	Boston, Mass.	Feb. 19
American Railway Engineering Association	Chicago, Ill.	Mch. 18–20

BIOGRAPHICAL NOTICES

EDGAR ARCHIBALD COLLINS

Edgar Archibald Collins was born at Truro, Cornwall, Nov. 16, 1877. He was the fifth (and youngest) son of J. H. Collins, a well known Cornish geologist and engineer, who died in 1916.

Edgar Collins spent part of his childhood at Rio Tinto, in Spain, and after returning to England was educated at Alleyne's School at Dulwich, near London.

His technical training was acquired by practical experience in Cornwall, supplemented by private study and by his father's teaching. This method of training for the work of a mining engineer was preferred by his father to that of the technical schools then available, and judging by its result, was not unsuccessful. It is, however, noteworthy that all members of the Collins family who were products of this system later sent, or planned to send, their own sons to technical schools.

Edgar Collins came to Gilpin County, Colorado, in 1894, and returned there in 1898, after several intermediate years spent in Cornwall. In Colorado he worked, under his brother Arthur, in the California and other mines of the Gilpin County district, and thereby gained a practical skill and experience as a working miner, and a habit of minute observation of vein phenomena, which proved of the greatest value in later years.

In 1899 he went to the Smuggler-Union at Telluride, as general assistant to his brother Arthur, and stood the brunt of 3 years of struggle with the Western Federation, gaining a reputation for quiet courage and sound work under the most difficult conditions.

After Arthur Collins' assassination in the Smuggler-Union office, in November, 1902, Edgar left Telluride, and shortly thereafter entered the employment of a syndicate headed by Arthur Winslow, of Boston, to search for and develop new mines. While so engaged he spent several unsuccessful months near Parral, in Mexico, and later visited and sampled the newly discovered district of Grandpa, afterward known as Goldfield, in Nevada. This led to the acquisition by the Winslow syndicate of the Combination mine, at first under lease and option; and Edgar Collins was placed in charge.

The Combination was really the starting point of Goldfield. It was a profitable mine before the discoveries at the Jumbo were made; and while the Combination, being a "Company-account" mine, controlled by a few responsible men, never attracted the publicity that centered around the sensationally profitable leases on the Jumbo and Mohawk, which publicity was used to further the feverish stock-dealings that characterized the new district. The Combination was really the pioneer mine, made the first shipments of rich ore, constructed the first water-line, and built the first mill (designed by F. L. Bosqui, an old friend and associate); and while it pursued a quiet and unobtrusive career up to the time of its sale to and incorporation with the Goldfield Consolidated, was probably, in proportion to the amount of money risked, the most profitable bonanza in the recent history of gold mining.

After the sale of the Combination, Edgar Collins left Goldfield for Tonopah, where he took charge of the Montana-Tonopah for C. E. Knox. This also was a profitable venture, although less sensationally so than the

Combination; and the new Montana mill, also designed by Bosqui, was another milestone in the metallurgical progress of Nevada.

In 1911 he went to the Transvaal, and served for a year as underground manager of the City Deep, one of the principal mines of the Central Rand. But the local conditions were uncongenial to him; he found the individual there unduly dominated by the organization. Too little initiative was accorded to the mine manager; a condition which perhaps avoids sensational blunders, but does not tend to develop the best in either men or mines. So he did not renew his Rand engagement, preferring to accept an offer from Mr. Knox to superintend the reopening and re-equipment of the Commonwealth mine in Arizona—which had just been acquired by a subsidiary of the Montana-Tonopah Company.

The Commonwealth was an old silver bonanza, around the fringe of which considerable areas of low-grade silver ore remained. This proved neither in tonnage nor grade equal to anticipation; and while mine and mill were completely equipped and ably handled, it was impossible to realize any substantial profit at the price of silver then prevailing, and after several years work was suspended.

After a short interlude in charge of the Oceanic quicksilver mine in California, Edgar Collins undertook the management of the Ridder mine, in the Altai mountains in southern Siberia. This is a property of the first magnitude; but the disintegrating effect of the Bolshevik régime had already commenced, and conditions as to labor and supplies were chaotic. He sacrificed 9 months in a patient endeavor to achieve the impossible, when the property was seized by the Bolsheviki, and he started for home with his family. After a long journey, uneventful excepting for discomfort, they arrived safely at Vancouver.

Possibly his vigorous constitution had become weakened by worry and inaction. At all events, shortly after his return to California he was attacked by pneumonia, and died at Ben Lomond on June 3, 1918, after a brief illness.

Edgar Collins was widely recognized as one of the most skillful mine managers of his day, his combination of energy and cool judgment being most effective. He was remarkably successful in handling men and getting the best out of them, and will long be remembered with affectionate respect by a large number of the men who worked under him.

He married, in 1906, Miss Grace Reynolds of San Francisco, who with three children, two boys and one girl, survive him. He was particularly fortunate in his domestic relations, and a great lover of home.

His only formal contribution to technical literature was a short paper, "A Prospecting Shaft in the Goldfield District, Goldfield, Nevada," in the *Transactions* of the Institution of Mining and Metallurgy, Vol. 15, pages 540–2. Several occasional contributions to the technical press illustrate the happy combination of lucidity and simplicity which he inherited from his father, and suggest the loss which his disinclination for formal writing occasioned to his fellows. He had a gift for letter writing which is rare now-a-days, and many of his letters written while traveling have passed from hand to hand.

Utterly loyal alike to employer and subordinate, a genial companion and a sound engineer, Edgar Collins will be widely missed, even outside the circle of his intimate friends and relatives. GEORGE E. COLLINS.

THEODORE EDWARD SCHWARZ*

Theodore Edward Schwarz, a member of the Institute since 1876, died at Boston on Oct. 1, 1917. He was born in Boston in 1855.

He was graduated at the English High School in that city in 1872, and the same year entered the Massachusetts Institute of Technology, where he studied mining engineering for a life profession, graduating in 1876.

In the following year, Charles Burleigh, of Fitchburg, Mass., offered him employment as a mining engineer at the Burleigh tunnel which was then being driven into Sherman Mountain, near Georgetown, Clear Creek County, Colorado. This was one of the first enterprises of its class in

THEODORE E. SCHWARZ.

Colorado, and the Burleigh machine drill was first introduced here. Accepting the position, Mr. Schwarz acquired valuable experience in tunnel work with air drills, as well as in practical mining.

In 1878, he closed his connection with this enterprise, and with a partner engaged in developing a prospect in Silver Creek near Lawson, where he gained some further knowledge of the patience and hard labor required to create a mine.

In the fall of that year, he became interested in a lease on the White lode in the district called Red Elephant, back of Lawson, where he sunk the first 250 ft. of what has since been known as the Schwarz shaft, developing the property and operating it for 2 years, during which time he

* Article by Frank Hall: "History of Colorado," vol. 4.

shipped considerable ore. At a later period, and until 1882, he prospected in Cascade district, Clear Creek County, and from time to time, examined and reported upon prospects for Boston and New York investors.

In 1882, he accepted the management of the Santa Rita copper and iron mines near Silver City, New Mexico. Here, he created extensive improvements including a very successful concentrating mill of 100 tons daily capacity, and developed the extensive native copper deposits of the property. The decline in the price of copper in 1883 caused the works to be closed at a time when, by thorough engineering and economical management, he had brought them to a self-sustaining condition.

In August, 1884, he was appointed Superintendent of the Yankee Girl mine, Red Mountain district, Ouray County, which had then been but crudely opened to a depth of 100 ft. During the 5 years of his management he developed it to a depth of about 1000 ft., opened new and productive ore shoots, erected the large hoisting plant and all surface improvements, and worked it at such profit that the Company was able to pay dividends amounting to nearly $1,000,000. The development of the Robinson mine, adjoining and a part of the property, to the point of productiveness was accomplished by him in the spring of 1889. It has since continued to be one of the most productive of Red Mountain orebodies.

In June, 1888, while conducting the Yankee Girl, he was engaged to superintend the Guston mine, also an adjoining property owned by the New Guston Co., Ltd., of London. It had acquired a heavy indebtedness, and been shut down full of water during the previous year. By his knowledge of the Red Mountain formation, which he had made a subject of careful study, he was able to place this mine on a dividend-paying basis within a few months after taking charge. For some time the company paid larger dividends in proportion to its capitalization than any other mine in the U. S. He induced the company to lease and bond the Little Annie and Smuggler claims adjoining the Guston workings, for about $80,000, believing the ground too valuable, although no pay ore was then showing in either claim. During the winter of 1889-90 he succeeded in opening a large body of fine ore in the Smuggler; it was purchased and became a profitable mine.

He was also, during his residence in the district, connected with the development of several other properties, among them the National Belle, now belonging to the American Belles Mines Co., Ltd., on which he located the present working shaft and sunk it to a depth of 300 ft.

In March, 1890, the health of his family having suffered from long exposure to the high altitudes, he resigned his management of the New Guston Company, receiving a formal vote of thanks from the directors and stock-holders of the company in London, in appreciation of his services. His own health, also, had become seriously impaired by his long residence at high altitude.

At the Colorado meeting of the Institute, in 1889, Mr. Schwarz presented the first comprehensive paper that had appeared, descriptive of the geology and ore deposits of the Red Mountain district.[1]

In 1890, he opened an office in Denver, as consulting mining engineer, making a specialty of mine management, and having in charge the development of several prominent properties, including a number of important undertakings in the San Juan country.

---

[1] *Trans.* (1889), **18**, 139.

MEMBERSHIP

NEW MEMBERS

The following list comprises the names of those persons who became members during the period Sept. 10, 1918, to Oct. 10, 1918.

ADDISON, HERBERT, Vice-pres. and Mgr., Big Horn Collieries Co., 412 Colorado Bldg., Denver, Colo.
ALLAN, ANDREW, JR. . . . . A. Allan & Son, Harrison, N. J.
AMI, HENRY M., Charge of War Metals and Minerals, British Embassy, Washington, D. C.
ALTHAR, HOMER C., Min. Engr., The Lorain Coal & Dock Co., Bridgeport, Belmont Co., Ohio.
BAKER, JOHN T. . . . . Pres., J. T. Baker Chemical Co., Phillipsburg, N. J.
BARBA, W. P., Lieut. Colonel, Ordnance, U. S. A., 2301 Connecticut Ave., Washington, D. C.
BENSON, JOHN PATY. . . . . Min. Engr., Aurora Cons. Mines Co., Aurora, Nev.
BOSWELL, H. F. . . . . Resident Inspector, Southern Railway System, St. Louis, Mo.
BRAUCHER, PETER S., Foundry Mgr., Philadelphia & Reading Ry. Co., Sixth & Perry St., Reading, Pa.
BRUGGER, MELVIN, Min. Engr., Société International Forestière et Minière du Congo, Forminière Mission, Tshikapa, Kasai, Congo Belge.
BRYAN, JOHN K. . . . . . Mgr., Electrolytic Zinc Co. Inc., Colgate, Baltimore, Md.
BUCHANAN, DEWITT WHEELER, Pres., Old Ben Coal Corpn., 1114 McCormick Bldg., Chicago, Ill.
BURGESS, CHARLES WESLEY, Met. Engr., The Dorr Co., 206 Miners Bank Bldg., Joplin, Mo.
CARON, M. H., Min. Engr. . . . . Mynweren, Batavia, Java, N. E. I.
CHENEY, CHARLES ALBERT, Geol., Crosby Exploration Co., 21 N. Butler St., Madison, Wis.
CLARK, GEORGE B., Asst. Valuation Engr., Colorado & Wyoming Railway Co., 515 Boston Bldg., Denver, Colo.
COOK, WALTER E. . . . . Chem. & Met., Camden Forge Co., Camden, N. J.
CROWDUS, JOHN WILLIAM. . . . . 1st Lieut., Engineers, U. S. A.
ELMORE, G. H., Cons. Engr., 1001–1003 Colonial Trust Bldg., Philadelphia, Pa.
FINDLEY, ALVIN I. . . . . Editor, *The Iron Age*, 239 W. 39th St., New York, N. Y.
FLINN, THOMAS C. . . . . Production Engr., Kennedy Foundry Co., Baltimore, Md.
FOX, OLIVER EDWIN. . . . . Min. & Civ. Engr., Fox, Peck & Fox, Harlan, Ky.
FRISBIE, HOWARD I., Efficiency Engr., Anaconda Copper Min. Co., Washoe Reduction Wks., Anaconda, Mont.
GILMAN, F. L., Wks. Mgr., National Conduit & Cable Co., Inc., Hastings-on-Hudson, N. Y.
HOLDER, G. C., Met. & Chem., Wheeler Condenser & Engineering Co., Carteret, N. J.
HORNE, JOSEPH A., Vice-pres. & Gen'l Supt., Yale & Towne Mfg. Co., Stamford, Conn.
KASJENS, JACOB G. . . . . Pres., Brass Foundry Co., 711 So. Adams St., Peoria, Ill.
KENNEDY, DANIEL J. . . . . Wks. Mgr., The Kennedy Valve Mfg. Co., Elmira, N. Y.
LEMKE, PAUL F. . . . . Supt., Bausch & Lomb Optical Co., Rochester, N. Y.
LEONARD, BART. C., Gen'l Supt. & Mgr., Riverside Coal Min. Co., South Fork, Pa.
LEVINGER, DAVID. . . . . Western Electric Co., Hawthorne Station, Chicago, Ill.
LUTTS, CARLTON G., Met., Metallurgical Laboratory, Boston Navy Yard, Boston, Mass.
MACLAY, EDGAR G., Foreman, Ferro-Alloy Plant, Anaconda Copper Min. Co., Great Falls, Mont.
MENNIE, T. S., Concentrator Mill Supt., McKinley-Darragh-Savage Mines of Cobalt, Ltd., Cobalt, Ont., Canada.
MERRITT, FLOYD C., Supt., Ramshorn Mine, Aetna Min. & Investment Co., Challis, Idaho.
MESSMER, FERD., Pres., Ferd. Messmer Mfg. Co., 2700 South 7th St., St. Louis, Mo.
MILLER, CHARLES A., Asst. Mine Supt., United Verde Copper Co., Jerome, Ariz.
MOTT, EVERETT H., Smelt. Supt., Sociedad Minera Backus y Johnston del Peru, Casapalca, Peru, S. A.

MOULSDALE, WILLIAM EDWARD......Met. Engr., 6 Castle St., Liverpool, England.
NICHOLS, F. E......................Supt., Danao Coal Mines, Danao, Cebu, P. I.
PAQUET, FRED., Supt., Metals Dept., Deloro Smelt. & Refin. Co., Deloro, Ont., Can.
PETINOT, N., Met. Engr., Vice-pres., United States Alloys Corpn., Buffalo, N. Y.
PILLOW, ALBERT E........Hampden Club, Hampden St., N. W., London, England.
RICHARDSON, EDRO........Pres., The Edro Richardson Brass Co., Baltimore, Md.
RIFFER, J. E., Prop., St. Catharines Brass Works, 62 Georges St., St. Catharines, Ont., Canada.
SCHELL, H. B., Asst. Mine Mgr., Mount Bischoff Extended Tin Min. Co., Waratah, Tasmania.
SHAFER, FREDERICK C..............Supt., Penberthy Injector Co., Detroit, Mich.
SILVER, ALBERT, Mill Supt., Belmont Shawmut Min. Co., Box 7, Shawmut, Tuolumne Co., Cal.
SLEETH, S. D., Gen'l Supt. of Foundries, Westinghouse Air Brake Co., Wilmerding, Pa.
SMIRNOFF, THEODORE V., Met. Engr., Upper Nsetsky Min. & Met. Co., Zexaterinburg, Perm, Russia.
WARNER, C. H.......................... Sec'y, 85 Mining Co., Valedon, N. M.
WHITE, JOHN H...........Mine Mgr., Climax Molybdenum Co., Climax, Colo.
WILKINSON, A. D., Asst. Smelter Supt., Cananea Cons. Copper Co., Cananea, Sonora, Mexico.
YOUNG, EDWARD L., Min. Engr., Dept. of the Interior, Bureau of Mines, Berkeley, Cal.
ZIEGLER, VICTOR, Cons. Geol., Prof. of Geology, Colorado School of Mines, Golden, Colo.

Associates

BARNES, FRANCIS M., JR., Dr. of Psychiatry, University Club Bldg., St. Louis, Mo.
BIRKENSTEIN, HARRY, Mgr., S. Birkenstein & Sons, 377 W. Ontario St., Chicago, Ill.
BUCKINGHAM, FISHER A., Flotation Div., Lubricating Oil Dept., Standard Oil Co., 200 Bush St., San Francisco, Cal.
BURTT, JOHN GURNEY, Pet. Geol., Roxana Petroleum Co. of Okla., Tulsa, Okla.
CARPENTER, MUREL EDWARD....Geol. Engr., Roxana Petroleum Co., Tulsa, Okla.
EVENS, HENRY W........Foundry Foreman, Lumen Bearing Co., Buffalo, N. Y.
GREEN, GEORGE L., Oil Geol., Gladstone Oil & Refin. Co., 222 Scott Thompson Bldg., Oklahoma City, Okla.
GREGORY, SEWELL HARDING, Morgan Crucible Co., Ltd., Battersea Works, Church Road, London S. W. 11, England.
HARLEY, L. J., JR., Pres., The Harley Co., Page Boulevard, Springfield, Mass.
HOLZHAUER, WILLIAM........Asst. Engr. of Tests, Milton Mfg. Co., Milton, Pa.
HORSFALL, HENRY A..............Cons. Engr., 29 West 39th St., New York, N. Y.
JONES, S. S...............Pres. & Gen'l Mgr., Towne Min. Co. Chloride, Ariz.
JUDSON, W. R., District Mgr., Allis-Chalmers Mfg. Co., Casilla 2653, Santiago, Chile, S. A.
KEEFE, JOHN J., Sec'y, Rochester Bronze & Aluminum Co., Inc., 23 Marietta St., Rochester, N. Y.
LAWTON, LEWIS H., Sec'y & Gen'l Mgr., Jonathan Bartley Crucible Co., Trenton, N. J.
MACKENZIE, ANDREW NICHOLLS, Pet. Geol., The Empire Gas & Fuel Co., Drawer S, Bartlesville, Okla.
MARTIN, CURTIS F........Co. B, 27th Engineers, American E. F., via New York.
MAXWELL, H. W..........Engr., Mine & Smelter Supply Co., El Paso, Texas.
MENG, ALVORD P., Chief Chem., Stamford Rolling Mills Co., Springdale, Conn.
MORRISON, CHARLES E., Sec'y & Treas., The James Morrison Brass Mfg. Co., Ltd., 97 Adelaide St., West, Toronto, Can.
PERLSTEIN, ISAAC N., Salesman, Great Western Smelt. & Refin. Co., 41st & Wallace Sts., Chicago, Ill.
SCHULTE, WILLIAM H., Gen'l Mgr., The Trenton Brass & Machine Co., Trenton, N. J.
STRATTON, JOSEPH B., Business Mgr., Andes Copper Min. Co., Casilla 230, Antofagasta, Chile.
VALERIUS, HERMAN POMEROY, Civ. & Mech. Engr., Brown Hoisting Machinery Co., American E. F., France.
WARREN, EDWARD C., Treas., Rochester Bronze & Aluminum Co. Inc., 23 Marietta St., Rochester, N. Y.

Junior Associates

BELL, FRANCIS M. . . . . Student, Colorado School of Mines, Golden, Colo.
BROWN, PRENTICE FARRAR . . . . . . Student, Colorado School of Mines, Golden, Colo.
CARRASCO, JUAN L. Student, Cornell University, Ithaca, N. Y.
FESSENDEN, J. H., JR. . . . . Electrician 2d Class (Radio) U. S. N. R. F.
GOODWIN, EDWARD H. . . . . Aviation Corps, Barracks No. 1, Champaign, Ill.
GOODWIN, GEORGE G. . . . . Student, Colorado School of Mines, Golden, Colo.
GRAHAM, DAVID J. . . . . Student, Colorado School of Mines, Golden, Colo.
McCLOSKEY, DOWNS, Lieut., 2d Regiment, First Brigade, Camp Jackson, S. C.
PETRITZ, WILLIAM E. . . . . . . Min. Engr., Anaconda Copper Min. Co., Butte, Mont.
ROMINE, THOMAS B. . . . . Student, Colorado School of Mines, Golden, Colo.
SERVISS, FRED LE VERNE . . . . . . Student, Colorado School of Mines, Golden, Colo.
TU, CHING FANG . . . . Kirin, China.

Change of Status, Junior Associate to Member

MADSON, FRANK H. . . . . Min. Engr., The McKinney Steel Co., Bessemer, Mich.

Total Membership, Oct. 10, 1918 7145

CHANGE OF ADDRESS OF MEMBERS

The following changes of address of members have been received at the Secretary's office during the period Sept. 10, 1918 to Oct. 10, 1918.

This list together with the list published in Bulletins No. 133 to 142, January to October, 1918, and the foregoing list of new members, therefore, supplements the annual list of members corrected to Jan. 1, 1918 and brings it up to the date of Oct. 10, 1918.

ADAMS, HENRY, Major, Chemical Warfare Service, U. S. A. P. O. 717, American E. F., France.
AGTHE, FRED T. . . . . 309 N. 5th St., Hannibal, Mo.
ALLEN, ROY H., Capt., Air Service, Bureau of Aircraft Production, 4th & Missouri Ave., Washington, D. C.
AMIDON, CLAUDE E., Chemical Warfare Section, Astoria H. L. & P. Co., Astoria, L. I.
ANDERSON, F. B., Mina La Taratana, Mina Minera de Manganeso, Bayamo, Oriente, Cuba.
ARAKAWA, EIJI, Min. & Met. Engr. . . . . . Sumitomo General Office, Osaka, Japan.
ASKIN, THOMAS B. H. . . . . Radio Station, Cavite, P. I.
BAGGE, N. O. . . . . 203 Broadway, New York, N. Y.
BAKER, DAVID F. . . . . . Blast Furnace Dept., National Tube Co. of Lorain, Ohio.
BATES, BENNETT R. . . . . Instructed to hold everything.
BATES, MOWRY . . . . 335 Iowa Bldg., Tulsa, Okla.
BATTEN, H. L., Lieut., Canadian Engineers, Care J. W. Morgan, Deer Park, Woldingham, Surrey, England.
BENOIST, E. J. Braden Copper Co., La Mina, Rancagua, Chile.
BERRAY, NILES S. . . . . 2219 West Washington, Los Angeles, Cal.
BLAIR, GEORGE S., 1st Lieut., Battery A, 320th Field Artillery, American P. O. 742, American E. F., France.
BLICKENSDERFER, F. C. . . . 1st Lieut., Ord. Dept., Edgewood Arsenal, Edgewood, Md.
BLOCK, JAMES A., Chief Engr. . . . . Crystal Coal & Coke Co., Crystal, West Va.
BORDEN, GAIL . . . . Box 222, Larchmont, N. Y.
BRIGGS, WALTER M. . . . . 2420 Ridge Road, Berkeley, Cal.
BRIGHAM, EDMUND D., Mgr., Railroad Comm., U. S. Railroad Administration, 910 Fidelity Bldg., Duluth, Minn.
BROCKUNIER, S. H., Supt., Chateaugay Ore & Iron Co., Lyon Mountain, N. Y.
BROOKS, FLOYD R., Lieut., Canadian Engineers, C. E. T. C., Seaford, Sussex, Eng.
BROWN, FREDERICK C. . . . . R. F. D. 5, Boise, Ida.
BROWN, GEORGE M., Co. G, 1st Engineer Replacement Regiment, Washington Barracks, D. C.
BRUNEL, FRANK P. . . . . Shoreham Apts., So. Magnolia, Long Beach, Cal.
BRUNEL, LOUIS J., 2d Lieut., 5th Field Artillery, Brigade Headquarters, American E. F., Care Postmaster, N. Y.

BRUNTON, D. W., Cons. Engr., Naval Consulting Board, Navy Bldg., Washington, D. C.
BRUYERE, ALAN .... Care Producing Dept., The Texas Co., Cisco, Texas.
BRYCE, ROBERT A .... 149 Indian Road, Toronto, Canada.
BUCKBY, D. W .... 1527 Harvard Ave., Salt Lake City, Utah.
BUNYAN, F. W., Asst. Chem., Noble Electric Steel Co., Heroult, Shasta Co., Cal.
BURGREN, ARTHUR W ...... Care A. B. Nanert, 4900 Cimmaron St., Los Angeles, Cal.
BURRELL, O. C .... 808 Sellwood Bldg., Duluth, Minn.
CALLAWAY, F. W., Corp., Miners & Sappers School, U. S. M. C., Quantico, Va.
CARLISLE, STANLEY B., Co. A, 346th Machine Gun Battalion, American P. O. 776, American E. F., France.
CHADWICK, JOHN P., American Smelt. & Refin. Co., Casilla 35, Antofagasta, Chile.
CHAPMAN, LEWIS C., Corp., 29th Engineers, American E. F., A. P. O. No. 714, France.
CHASE, J. L., Cadet 2011205, Canadian Engineers Training Depot, St. Johns, P. Q., Canada.
CHATIN, AUGUST H., 472d Engineers, U. S. A., Bldg. C, Room 4–107, Henry Parks Bldg., Washington, D. C.
CONRADS, R. A .... 804 Newhouse Bldg., Salt Lake City, Utah.
CORBIN, J. ROSS .... 123 Clinton Ave., New Rochelle, N. Y.
COULDREY, PAUL S., Corp., 313134 W. R. 5 Works Co., Saltpans, nr. Sandwich, Kent, England.
COWANS, FREDERICK, Gen'l Mgr., Utah Cons. Min. Co., 608 Dooly Block, Salt Lake City, Utah.
CROXTON, DAVID T., Pres., Cleveland Furnace Co., 315 Clark Ave., S. W., Cleveland, Ohio.
CUNNIFF, BERNARD, American Magnesium Corpn., Room 1364, 200 Fifth Ave., New York, N. Y.
CUNNINGHAM, GEORGE H .... Box 856, Melbourne, Australia.
DALE, RALPH, Lieut., Co. E, 114th Engineers, A. E. F., Care Postmaster, N. Y.
DAMAN, A. C .... 4547 Wolff St., Denver, Colo.
DAULTON, THEODORE M., Gen'l Mgr., Placer Gold Mines Co., 1002 Third Ave., Seattle, Wash.
DAVIS, LEVERETT, Min. Engr.; Mgr., The Commonwealth Min. Co., 911–15 Foster Bldg., Denver, Colo.
DEVINE, JOHN C .... Troy-Arizona Copper Co., Kelvin, Ariz.
DIETZ, J. H .... American Zinc Products Co., Greencastle, Ind.
DOVE, D. R., Candidate, 21st Training Battery, F. A. C. O. T. S., Camp Zachary Taylor, Ky.
DUDLEY, BOYD, JR., Capt., Ordnance Dept., Inspection Div., Watervliet Arsenal, Watervliet, N. Y.
DUNBAR, DOUGLAS MACD., Co. 20, 5th Bat., 163 Depot Brigade, Camp Dodge, Iowa.
EDDINGFIELD, F. T., Min. Engr., Bureau of Mines, 1440 Harvard St., Washington, D. C.
EULICH, ARTILEUS V., Co. H, 2d Engineers Training Regiment, Camp A. A., Humphreys, Va.
FARNHAM, C. MASON .... Geol., American Metal Co., Barre Plains, Mass.
FERGUSON, CLAUDE .... Supt., Consolidated Arizona Smelting Co., Ocotillo, Ariz.
FISHER, THOMAS E .... 5 Baker Ave., Dover, N. J.
FORBES, D. D .... Instructed to hold everything.
FOURNIER, E. ANTUNES .... Apartado 745, Mexico City, Mexico.
FULLAWAY, RICHARD M., Co. B, 4th U. S. Engineers, American E. F., Care Postmaster, N. Y.
GAHL, RUDOLF .... Cons. Met., 1213 First National Bank Bldg., Denver, Colo.
GALPIN, SIDNEY L .... 620½ Sherman Ave., Hutchinson, Kansas.
GARRISON, MURRAY E .... Cadet, Squadron 1, Camp Dick, Dallas, Texas.
GEIB, FRANCIS HODGSON .... Co. 2, E. O. T. S., Camp Humphreys, Va.
GOODRICH, ROBERT RHEA .... 521 E. 3d St., Anaconda, Mont.
GORELANGTON, CECIL A .... Capt., Engineer Corps, U. S. Army.
GOTSCH, OSCAR, JR., Chief Machinist's Mate, U. S. Navy Steam Engrg. School, Stevens Institute, Hoboken, N. J.
GRANT, ULYSSES S., IV, 2d Lieut., Textile Equipment Branch, O. Q. M. G., Room 3414, Unit G, 19th & B. Sts., Washington, D. C.
GRATON, LOUIS C ... Copper Producers Committee, 60 Broadway, New York, N. Y.

GREEN, WALDRON A., 2d Lieut., Co. D, 27th Engineers, A. E. F., Care Postmaster, N. Y.
GUITERMAN, KENNETH S....................Box 452, Lawrence, L. I., N. Y.
HALL, R. G., Resident Mgr., Burma Mines Ltd., Namtu, Upper Shan States, Burma.
HAMPTON, WILLIAM H., Gas Defense Div., Chemical Warfare Service, U. S. A., Long Island City, N. Y.
HARDER, OSCAR E....................Mellon Institute, Pittsburgh, Pa.
HARMS, PURL L., Major, 19th U. S. Infantry, 18th Division, Camp Travis, Texas.
HARRINGTON, D....................U. S. Bureau of Mines, Golden, Colo.
HEIZER, O. F....................Supt., Sheepranch Mine, Sheepranch, Cal.
HERRON, JAMES H., The James H. Herron Co., 1364 West Third St., Cleveland, Ohio.
HILBY, GEORGE R..........Lieut., Headquarters, Ellington Field, Houston, Texas.
HOFFMANN, KARL F., Cons. Engr., General Development Co., 61 Broadway, New York, N. Y.
HOHL, L. JOHN..................Cons. Engr., 1834 Delaware St., Berkeley, Cal.
HOLMBERG, CLYDE L....................Box 301, Virginia, Minn.
HOUSHOLDER, E. ROSS......Student, Co. 4, E. O. T. S., Camp Humphreys, Va.
HU, S. H....................Met., Illinois Steel Co., Gary, Ind.
HUNTLEY, LOUIS G., Pres., Island Oil & Transport Corpn., 62 Cedar St., New York, N. Y.
HUTCHINS, R. GROSVENOR, JR., Head, Bureau of Home & Hospital Service, American Red Cross, France.
IHLSENG, AXEL O....................Cons. Engr., Joplin, Mo.
IRELAND, ROBERT R..........Student, Colorado School of Mines, Golden, Colo.
IRWIN, JOSEPH S..........2d Lieut. of Infantry, U. S. Army, Camp Perry, Ohio.
JAEGER, FREDERICK....................25 Bergen Ave., Jamaica, N. Y.
JARRETT, FRED G....................Buckley, Pierce Co., Washington.
JONES, WENDELL T. . Co. D, 316th Engineers, American E. F., Care Postmaster, N. Y.
KEEDY, DYKE V....................Care Norton & Co., Niagara Falls, N. Y.
KENDALL, A....................Box 342, Hancock, Mich.
KILIANI, RICHARD B. T., Sec'y & Treas., Hardinge Conical Mill Co., Room 525, First National Bank Bldg., Denver, Colo.
KIRBY, A. G., Gen'l Mgr., Darwin Lead & Silver Mines & Dev. Corp., 818 So. 6th East St., Salt Lake City, Utah.
KIVARI, ARTHUR M....................400 Empire Bldg., Denver, Colo.
KLEIN, KARL F....................543 West 123d St., New York, N. Y.
KROEGER, ADOLPH C..............Co. 1-b, E. O. T. S., Camp A. A. Humphreys, Va.
LADOO, RAYMOND B., John B. Guernsey & Co., Inc., 411 Strickland Bldg., Roanoke, Va.
LEHMANN, CHARLES, Min. & Met. Engr., 13 Chetsworth Road, West Norwood, London, S. E., England.
LEWIS, ROBERT S....................Box 902, Stanford University, Cal.
LINTHICUM, J. F......Night Supt., Monsanto Chemical Works, St. Louis, Mo.
LOERPABEL, W. HARRISON............Co. 5, E. O. T. S., Camp Humphreys, Va.
LUNT, HORACE F., Capt., Engineer Officers' Training Camp, Camp Humphreys, Va.
MACDONALD, H. D....................American Zinc Co., Mascot, Tenn.
MACNICHOL, A. W., Ensign, U. S. N., U. S. S. Pastores, Care Postmaster, N. Y.
MACAULAY, R. M., The Consolidated Min. & Smelt. Co. of Canada, Ltd., Rossland, B. C., Canada.
MARSH, A. G., Corp., Co. C, 18th Railway Engineers, American E. F., Care Postmaster, N. Y.
MASTERS, JOHN E....................Box 413, Livermore, Cal.
MEANS, ALAN H., 2d Lieut., F. A., N. A., 314th Field Artillery, 155 Art. Brigade, American E. F., Care Postmaster, N. Y.
MEGRAW, H. A., Bureau of Aircraft Production, 435 Bldg. D, 4th & Missouri Ave., Washington, D. C.
MERRITT, FLOYD C....................Instructed to hold Bulletins and mail.
MILLER, WILLIAM B., 2d Lieut., Co. B, 1st Gas Regiment, A. P. O. 706, American E. F.
MOGA, JOHN AUGUST, Student, Officers' Training Camp, Co. A, Coast Artillery School, Fort Monroe, Va.
MOORE, GEORGE P....................The Wallace Barnes Co., Bristol, Conn.
MOTT, L. C., Min. Engr., Vice-pres., Western Metals Co., 626 Security Bldg., Los Angeles, Cal.
MUIR, T. K....................809 Trust & Savings Bank Bldg., Los Angeles, Cal.

MURRAY, MALCOLM S....Capt. Engineers, Co. C, 98th Engineers, Camp Leach, D. C.
NEUSTAEDTER, ARTHUR..............30 Wegman Parkway, Jersey City, N. J.
NEWMAN, M. A.......................................Nelson, Clark Co., Nev.
NICHOLAS, ASKIN M., McLaughlin, Rusell, Coe & Sprague, 165 Broadway, New York, N. Y.
OFFICER, HERBERT G., 2d Lieut., Aviation Section, 2025 H. St., N. W., Washington, D. C.
ORYNSKI, JOHN B......................1104 N. Olive St., San Antonio, Texas.
OSBORN, F. W........................Box 3, Great Neck Sta., Long Island, N. Y.
PACKARD, HENRY J...............Care Pacific Tungsten Co., Mill City, Nev.
PADDISON, L. F., U. S. Smelt., Refin. & Min. Exploration Co., 1504 Hobart Bldg., San Francisco, Cal.
PAGE, WILLIAM N.......Cons. Engr., 1863 Kalorama Road, Washington, D. C.
PALMER, W. F., Pvt., Co. D, 1st Replacement Regt., Washington Barracks, D. C.
PARKER, MORRIS B., Cons. Min. Engr., 1541 Poinsettia Place, Hollywood, Los Angeles, Cal.
PLACE, RICHARD G., Chief Chem., The Golden Age Min. & Reduction Co., Jamestown S. R., Boulder, Colo.
POTT, JOHN N............................611 So. Third St., Tacoma, Wash.
PROCTOR, ISRAEL O............................2740 State St., Butte, Mont.
QUEEN, EDWARD L....................City Transfer Co., Douglas, Ariz.
RANDALL, JOHN....................................Mogollon, N. M.
RATHBUN, F. D.......................Arizona Copper Co., Metcalf, Ariz.
REA, WALTER C......................Braden Copper Co., Rancagua, Chile.
REED, WILLIAM, Lieut., M. C., R. E., H. Q. Special Corps, R. E., Second Army, B. E. F.
REHFUSS, W. C., Ensign, U. S. N. R. F., Naval Proving Grounds, Indian Head, Md.
REICHEL, DAN.....................................Box 100, Miami, Ariz.
REID, A. SCOTT, Lieut., Seaforth Highlanders, 1st Garrison Battalion, The Royal Scotts, Egyptian E. F.
RENWICK, CHARLES W.....................1226 N. 3d Ave., Knoxville, Tenn.
ROBERTS, JOHN R....................................Box 111, Cisco, Texas.
RODGERS, GEORGE B., Principal Asst., Engr., Air Nitrates Corpn., Agent Ordnance Dept., 469 Fifth Ave., New York, N. Y.
ROSS, FRANK A............................University Club, Spokane, Wash.
RENE DE SALLIER DU PIN................202 Clinton St., Watertown, N. Y.
SALSICH, LE ROY.....Asst. District Mgr., Oliver Iron Min. Co., Hibbing, Minn.
SCANLAN, W. L...M. A. Hanna & Co., 1300 Leader News Bldg., Cleveland, Ohio.
SCHINDLER, DONALD F..............Co. 5, E. O. T. S., Camp Humphreys, Va.
SEARS, STANLEY C..............Capt., Engineers, U. S. A., Camp Humphreys, Va.
SENG, CHAN KEY.................................Instructed to hold all mail.
SHAYES, FRED P........Lieut., Air Service, American E. F., Care Postmaster, N. Y.
SHOEMAKER, GEORGE M., Pres. & Gen'l Mgr., The Red Dragon Coal Co., Corbin, Ky.
SHUMWAY, RALPH W......Chief Engr., Wolf Park Coal Co., Canon City, Colo.
SIMPSON, GEORGE N., Gen'l Mgr., Wood Equipment Co., 1220 East 75th St., Grand Crossing, Chicago, Ill.
SMART, ORNAN B...........Tonopah Belmont Development Co., Tonopah, Nev.
SMITH, HOWARD D...........Cons. Min. Engr., 60 Broadway, New York, N. Y.
STEDMAN, W. A............................The Dorr Co., Westport, Conn.
STEGER, PAUL, Care Compania de Minerales y Metales, S. A., Santa Eulalia, Chihuahua, Mexico.
STEINDLER, EUGENE L., Gen'l Mgr., Dominion Reduction Co., Ltd., 42 Broadway, New York, N. Y.
STEINEM, CHESTER........2d Lieut., Heavy (Coast) Artillery, Fort Monroe, Va.
STIMPSON, C. W., Mgr., Stimpson Equipment Co., 318 Felt Bldg., Salt Lake City, Utah.
STUART, C. E.........Capt., Staff College, American E. F., Care Postmaster, N. Y.
STÜTZ, ERNEST...............Engineers Club, 32 West 40th St., New York, N. Y.
SULLIVAN, CLARKE.........Capt., Co. A, 209th Engineers, Camp Sheridan, Ala.
SUYDAM, A. G...........................406 Hobart Bldg., San Francisco, Cal.
SWEET, B. G...............St. Louis Smelt. & Refin. Works, St. Francois, Mo.
SWIFT, ERNEST LEE.........................505 Fairbanks Ave., Oakland, Cal.
TEAS, PIERSON..........2d Lieut., O. M. C. S., Camp Raritan, Metuchen, N. J.
THAYER, HARRY S.........................1146 Pleasant St., Boulder, Colo.
THOMAS, EDWARD G.........................228 S. Oxford St., Los Angeles, Cal.

THOMPSON, EDWARD C., Capt., Chemical Warfare Section, Edgewood Arsenal, Edgewood, Md.
THOMPSON, LESTER S., Sgt., Co. C, 29th Engineers, American E. F., Care Postmaster, N. Y.
TOENGES, ALBERT L. .... Mines Efficiency Co., Duluth, Minn.
TOWER, RAY E. .... Care Silver Fissure Min. Co., Polaris, Mont.
TRACY, CLARENCE A. .... 2727 Hobart Ave., Los Angeles, Cal.
TRAUERMAN, CARL J. .... 132 E. Aluminum St., Butte, Mont.
TREICHLER, H. E. .... Engr., Gulf Sulphur Co., Matagorda, Texas.
TUCK, DOUGLAS .... Engrg. Dept., United Verde Copper Co., Jerome, Ariz.
TYLER, NAT, JR. .... Short Hills, N. J.
VAIL, RICHARD H., Capt., Technical Div., Chemical Warfare Service, American E. F., Care Postmaster, N. Y.
VALERIUS, HERMAN POMEROY, Civ. & Mech. Engr., Brown Hoisting Machinery Co., American E. F., France.
VAN LAW, CARLOS W. .... Room 819, 55 Congress St., Boston, Mass.
VARLEY, THOMAS .... U. S. Bureau of Mines, Salt Lake City, Utah.
WATROUS, MARK U. .... Box 561, Monte Vista, Colo.
WAY, KARL M. .... Care Bradway Coal Co., Center Point, Ind.
WEED, ROBERT C., Chicago District Ordnance Office, Inspection Div., 155 E. Superior St., Chicago, Ill.
WEEKS, L. G. .... C. Q. M. (A), U. S. N., Naval Proving Grounds, Indian Head, Md.
WILKIN, GARRATT S. .... 617 E. South Temple St., Salt Lake City, Utah.
WILLIAMS, CHARLES F., 2d Lieut., Co. D, 30th Gas Regiment, American E. F., Care Postmaster, N. Y.
WILLIAMS, FRED P., Supt., Carlota Pyrite Mine, Davison Sulphur & Phosphate Co., Cumanayagua, Cuba.
WILSON, ELWOOD J. .... Montvale, N. J.
WILSON, GORDON, Mill & Cyanide Supt., Fresnillo Co., Fresnillo, Zacatecas, Mexico.
WILSON, HARRY R. .... 32d Training Battery, F. A. C. O. T. S., Camp Taylor, Ky.
WITT, HERBERT N. ..... U. S. N. R. F., Officers Material School, Mare Island, Cal.
WOLVERTON, F. M., Act. Corp., Measles Quarantine Camp No 1, Camp McArthur, Texas.
WOODS, CLARENCE .... Instructed to hold everything.
WRIGHT, IRA L. .... Box 306, Silver City, New Mexico.
YOUNG, WILLIAM A. .... Kendall, Mont.
YOUNG, WILLIAM G. .... 914 So. Alvarado St., Los Angeles, Cal.
ZIMMERMAN, S. H., Candidate, Army Candidates School, Engineer Section, A. P. O. No. 714, American E. F., France.

MEMBERS' ADDRESSES WANTED

Name. Last address of Record from which Mail has been returned.

ARMSTRONG, CLIFTON T. .... 347 Manhattan Ave., New York, N. Y.
ASHMORE, E. P. .... 504 Sherbourne St., Toronto, Ont., Canada.
BARNARD, C. W. .... North Chicago Hospital, 2551 N. Clark St., Chicago, Ill.
BARNETT, WILLIAM J. .... 8 Waterloo Place, Pall Mall, London S. W., England.
BIRD, FRANK H. .... Butler Hotel, Seattle, Wash.
BLANCHARD, RALPH C. .... 3 Lombard St., London, England.
BOAS, ROSS H. .... Highland Boy Mine, Bingham Canyon, Utah.
BREEDING, F. O. .... Eden Min. Co., Bluefields, Nicaragua.
BROCKMANN, GUILLERMO .... 120 Broadway, New York, N. Y.
BROOKE, LIONEL .... Minas del Tajo, Rosario, Sin., Mexico.
BROWNE, ARTHUR B. .... Malleable Iron Fittings Co., Branford, Conn.
BRYANT, GEORGE W. .... Apartado 86, Guanajuato, Gto., Mex.
BYERS, WHEATON B. .... 50 Hampton Hall, Cambridge, Mass.
CONOVER, M. J. .... Hotel Bellevue, San Francisco, Cal.
DETERT, WILLIAM F. .... Jackson, Amador Co., Cal.
EHLERS, L. W. .... 2137 St. Louis Ave., St. Louis, Mo.
DEFARIA, C. C., Fiscal das Estradas, Rua Condo do Bomfim, No. 46, Rio de Janeiro, Brazil.
FIELDING, SIR CHARLES .... Belmont, Faversham, Kent, England.
GOLDSMITH, OSHER .... Rolla, Mo.
HERR, J. CAMPBELL .... Box 556, State College, Pa.

HOVLAND, HENRY B..............Los Angeles Athletic Club, Los Angeles, Cal.
KAY, DAVID NELSON....................Ray Cons. Copper Co., Hayden, Ariz.
KERNAN, THOMAS H., School of Mines Experiment Sta., Univ. of Minnesota, Minneapolis, Minn.
KLUGESCHEID, WALTER P...................616 W. 113th St., New York, N. Y.
KONSELMAN, ALBERT S..Globe, Ariz.
MEE, WHITNEY P......................Apt. 14, Binkley Apts., El Paso, Texas.
MORRIS, JOHN M...Rolla, Mo.
NICHOLSON, FRANCIS..........................Charlotte Court House, Va.
RALEIGH, JOSEPH R............Rossville, via Cooktown, Queensland, Australia.
ROBERTS, EDWARD J., Gen'l Mgr., Nevada Pyramind Min. Co., Riverside Hotel, Reno, Nev.
ROSS, HERBERT W...............314 Pacific Ave., Piedmont, Oakland, Cal.
SIMPSON, KENNETH M......................57 Post St., San Francisco, Cal.
STICKNEY, WILLIAM H.............................708 N. Center St., Reno, Nev.
TAO, H. T...Rolla, Mo.
TAPLIN, THOMAS J., JR...............16 Lordship Park, London N. 16, England.
TONG, SING KOW...........................404 W. 115th St., New York, N. Y.
TREAT, LLOYD B., Canadian Ingersoll-Rand Co., Bank of Toronto Bldg., Montreal, Canada.
VANRENSSELAER, ARTHUR M................119 E. 51st St., New York, N. Y.
WONG, S. C...........................Care School of Mines, Butte, Mont.
WONG, YIN CHARLES..Rolla, Mo.
WOO, W. K.............M 70 Sing Kong Li, Minghong Road, Shanghai, China.

NECROLOGY

(See also "Died in Service")

The deaths of the following members were reported to the Secretary's office during the month Sept. 10, 1918, to Oct. 10, 1918.

Date of Election.	Name.	Date of Death.
1917	Ballamy, John H.	Aug. 9, 1918.
1891	Buhl, Frank H	June 17, 1918.
1876	Kent, William	Sept. 18, 1918.
1912	McLeod, Howard D	Aug. 6, 1918.
1902	Moffat, John	June 28, 1918.

CANDIDATES FOR MEMBERSHIP

APPLICATION FOR MEMBERSHIP.—The Institute desires to extend its privileges to every person to whom it can be of service. On the other hand, it is not desirable that persons should be admitted to membership in classes for which they are not qualified. Members of the Institute can be of great service if they will make a practice of glancing through the list of applicants and promptly notifying the Committee on Membership, or the Secretary of the Institute, of any persons whom they think should not be classified in accordance with the list given.

Applications Lacking Endorsement

Applications for membership have been received from Mr. Braecke and Mr. Wilkie, whose records are given below. These applications lack the necessary number of endorsers, but since these candidates live at some distance from the headquarters of the Institute, their records are published here in order that any members who are acquainted with them may be advised of the circumstances and may have an opportunity of writing to the Secretary endorsing these candidates.

Members

Gustave Braecke, La Carolina, Spain.
Proposed by A. DeDeken.
Born 1860, Nieuport, Belgium. 1886, Grad., School of Mines, Liége, Belgium, M. E. and Engr. of Arts and Manufactures. 1887–91, Ore-dressing Dept., Humboldt Engng. Works, Kalk, Germany. 1891–1901, Prospecting, Northern Transvaal; Mgr., Molyneux mines, Witwatersrand, Transvaal. 1901–03, Mgr., Gwendoline gold mine, Korea. 1903–06, Mgr., Mina San Vicente, Société La Nouvelle Montagne, Spain. 1906–07, Prospecting for zinc, Djendli mine, Arzelia. 1907–11, Mgr., Ollin mines, North Spain. 1911–13, Reporting in Spain for Société d'Etudes Minière, Brussels. 1914–18, Mgr., Lead mines, Curas and Soldado, and Technical Mgr. New Cerdenillo, silver-lead mines, La Carolina, Spain.
Present position: Mgr., Société Curas et Soldado de Carolina.

Donald Cook Wilkie, Serembau, Federated Malay States.
Proposed by
Born 1879, Dundee, Scotland. Brothers' school, Penang, Straits Settlements; Baptists' School, Rangoon, Burmah; Donaldson's School, Dundee, Scotland; 1890–92, Wallacetown School, Dundee, Scotland. 1892–98, Mechanical and electrical construction and repair work; engr. experience; drafting room; shop at sea, Ross & Wilkie, Scotland. 1898–99, Asst. Engr., China Borneo Co., Ltd., Sandakan, B. N., Borneo. 1901–03, Salvage Depot., Tangong Pagar Dock Co., Ltd., Singapore. 1903–10, Engr., Pyritical Ore Installation, Sungei Besi recovery of tin stone from arsenical and sulphurous ores, The Straits Trading Co., Ltd., Sungei Besi, Malay States.
Present position—1910 to date: Supt. Engr., Linggi Plantations Ltd.

The following persons have been proposed during the period Sept. 10, 1918, to Oct. 10, 1918, for election as members of the Institute. Their names are published for the information of Members and Associates, from whom the Committee on Membership earnestly invites confidential communications, favorable or unfavorable, concerning these candidates. A sufficient period (varying in the discretion of the Committee, according to the residence of the candidate) will be allowed for the reception of such communications, before any action upon these names by the Committee. After the lapse of this period, the Committee will recommend action of the Board of Directors, which has the power of final election.

Members

C. W. Ankemy, Colorado Springs, Colo.
Proposed by A. S. Blomfield, Charles E. Van Barneveld, L. S. Harner.
Born 1882, Iowa. 1902, High School, Colo. 1903–08, Min., ore crushing, amalgamating and cyaniding, Liberty Bell Gold Min. Co. 1908–18, Grinding, amalgamation, classification, slime settling and cyaniding, Golden Cycle Min. & Reduction Co.
Present position: Foreman, fine grinding, amalgamation, cyaniding, Golden Cycle Min. & Reduction Co.

William Bangser, Bethlehem, Pa.
Proposed by R. M. Bird, Albert P. Spooner, W. R. Shimer.
Born 1889, Liban, Russia. 1908–13, Columbia Univ., M. E. 1913–15, Asst. Supt. of Treatment; 1915–1916, Supt. of Treatment, Bethlehem, Steel Co.
Present position—1916 to date: Asst. Supt., Treatment Dept., Bethlehem, Pa.

Elvin Edwards Boon, Edgewood Park, Pa.
Proposed by Graham Bright, G. B. Rosenblatt, J. H. Payne.
Born 1890, Chrisman, Ill. 1911, Grad., Univ. of Illinois, B. S. and E. E. 1911–12, Apprentice and Tester; 1913–15, Correspondent Min. Sec.; 1915–17, Commercial Engr., Metal Min., Westinghouse Electric & Mfg. Co.
Present position –1917 to date: Acting Mgr. and Min. Sec., Industrial Sales Dept., Westinghouse Electric & Mfg. Co.

Giovanni Bruscantini, Santiago de Cuba.
Proposed by Walter Harvey Weed, F. D. Paluchi, Benjamin B. Lawrence.
Born 1880, Montecosaro, Italy. 1893–97, Industrial Inst. of Fermo, Italy. 1900–05 and 10, Grad., Liége Univ., Belgium, E. M. 1905–10, Prof. of Hydraulics and Electricity, Glons (Belgian) Politecnic Inst. 1911–12, Mgr., Compagnie Minière et Métallurgique de la haute Italie, Verres, Italy. 1913–14, Mgr., Cumaragua copper mine, Venezuela. 1915, at home in Italy. 1915–17, Cons. Engr., Havana, Cuba.
Present position—1917 to date: Mgr., Sindicato Minero de Cuba.

Frank Buttram, Oklahoma City, Okla.
Proposed by Irving Perrine, Charles N. Gould, C. W. Shannon.
Born 1886, Marietta, Okla. 1910, Grad., Univ. of Oklahoma, A. B. 1910–12, Grad. Student, Univ. of Oklahoma, A. M. 1910–13, Chem. and Field Geol., Oklahoma Geological Survey. Author of "Glass Sands of Oklahoma," "Volcanic Ash in Oklahoma," "Cushing Oil Field, Oklahoma," Survey *Bulletin*.
Present position—1913 to date: Geol., Fortuna Oil Co.

Louis Francis Clark, Chile, S. A.
Proposed by Albert A. Hoffman, Ira L. Greninger, Louis R. Wallace.
Born 1891, Lowell, Mich. 1914, Grad., Colorado School of Mines, E. M. 1912 (Summer), Mine surveying and mapping, Michigan Gypsum Co., Grand Rapids, Mich. 1914, Diamond drill helper; classifier man, cyanide mill, Hedley Gold Min. Co., Hedley, B. C., Canada. 1914–15, Junior Min. Engr., U. S. Civil Service, Bureau of Mines, Pittsburgh, Pa. 1915, Supervisor, rectification of holder oils, Deep Water plant, E. I. Dupont de Nemours Co., Deep Water, N. J. 1915–16, Chem., Smokeless Powder Dept., Experimental Station, Du Pont Co., Wilmington, Del.
Present position—1916 to date: Chem., Andes Copper Min. Co., Potrerillos.

Reid Burchfield Cochran, Aire Libre, Puebla, Mex.
Proposed by Edward L. Dufourcq, Adolph Martinez, D. C. Brown.
Born 1880, Cadiz, Ohio. Cadiz Public Schools. 1899, Grad., Cadiz High School. 1899–1901, Franklin College, New Athens, Ohio. 1901–05, Case School of Applied Science, Cleveland, Ohio, B. S. and E. M. 1905, Engr. Corp., Cleveland & Pittsburgh Division of Pennsylvania R. R. 1905–09, Surveyor and Assayer, Compañia Metalurgica Mexicana, Sierra Mojada, Coahuila unit. 1908–09, Mine Foreman, Compañia Metalurgica, San Pedro, San Luis Potosi unit. 1909–12, Mgr., Compañia Minera el Barreno y Annexas, S. A., San Pedro, S. L. P., Mex. 1913, Asst. Supt., Santa Gertrudis mine, Pachuca, Hidalgo, Mex. 1914–17, Examining Engr., unattached.
Present position—1917 to date: Mine Supt., The Tezuitlan Copper Co.

Thomas Cooper Connar, Zanesville, Ohio.
Proposed by Sanford B. Belden, S. A. Taylor, F. A. Ray.
Born 1845, New Concord, Ohio. 1867, Grad., Muskingum College, A. B.; 1871, A. M. 1869–1872, Asst. Engr. for Louis Nickerson, St. Louis, Mo. 1872, Civil Engrs., Cruse Park & Co., Texas. 1875–80, Surveys and contracting, Ohio. 1880–84, Engr. on constr., Muskingum County Ry. 1884–86, Various surveys and geol. work for oil and coal. 1886–88, Res. Engr., Constr., Kilbuck branch of the C. A. & C. Ry. 1888, County Surveyor, Muskingum County, Ohio. 1896, Min. Engr., McKinney & Huggins, Ohio. 1900, Cons. Engr., H. C. & I. Co., Cleveland, Ohio. 1904, Min. Engr., Tropic Min. Co.
Present position: Chief Engr., Zanesville Coal Co., Tropic Min. Co. and Standard Hocking Coal Co.

Walter Grey Crichton, Charleston, W. Va.
Proposed by J. S. Cheyney, D. M. Stackhouse, Andrew B. Crichton.
Born 1888, Phillipsburg, Pa. 1908–10, West Virginia Univ. 1911–16, Min. Engr., Blue Creek Coal & Land Co., Charleston, W. Va.
Present position—1916 to date: Private mining engineering.

Edwin Oliver Daue, Easton, Pa.
Proposed by A. MacDonald, R. B. Eldredge, Horace F. Lunt.
Born 1879, Woodland, Wis. 1888–95, Public Schools, Milwaukee, Wis. 1895–98, High School, Milwaukee, Wis. 1900–03, Grad., Michigan College of Mines, Houghton, Mich., B. S. and M. E. 1903, Draughtsman, Philip Argall, Denver, Colo. 1903–04, Engr., Assayer and Mine Foreman, La Leonesa Min. Co., Matagalpa,

Nicaragua. 1905, Engr. of Constr., Mountain Copper Co., Ltd., Martinez, Cal.; Engr., Imperial Copper Co., Silverbell, Ariz. 1905–07, Engr., Minas Dolores y Anexas, Matehuala, S. L. P., Mexico. 1907–08, Supt., Reforma Min. and Mill. Co., Campa Morada, Gto., Mexico. 1908–09, Mgr., Cia. Minera la Quimica y Anexas, Toluca, Mexico. 1909–12, Mine Mgr., Fiduciary Co., Chicago, Ill. 1912–13, Cons. practice, Chicago. 1913–15, Field Engr., Mines Co. of America; Mgr., Dolores Mines Co., Chihuahua, Mexico. 1915–16, Cons. practice, Los Angeles, Cal. 1917, Gen'l Supt., Primos Min. and Mill. Co. and Primos Chemical Co., Lakewood, Colo. 1918, Mill and Cyanide Supt.; cons. practice; Tough-Oakes Gold Mines, Ltd., Ont., Canada.
Present position: Capt., Engrs. Corps, U. S. A.

Sumner Ford Eaton, Colombia, S. A.
Proposed by H. A. Guess, William F. Ward, C. J. London.
Born 1884, Watertown, Wis. Central High School, Minneapolis, Minn. 1 yr. Univ. of Minn. 1902–04, Underground work, various Western mines. 1904–06, Shift Boss, Contr., general underground work and shaft sinking, Old Mexico. 1907–08, Shift Boss, Eureka mine, Globe, Ariz. 1909–10, Prospecting. 1911–12, At Home, Tacoma, Wash., other business. 1912–14, Contr., Britannia Min. & Smelt. Co., Britannia Beach, B. C. 1914–17, Mine Foreman, Vantrent Min. Co., Dairy Farm mine, Vantrent, Cal.
Present position—1917 to date: Supt., Guamoco Min. Co.

Shinzo Endo, Tokyo, Japan.
Proposed by S. Yamanouchi, H. W. Hardinge, A. E. Blackwood.
Born 1866, Sendai, Japan. 1890, Grad., College of Engineering, Tokyo Imperial Univ. 1890–5, Chem., sulphuric acid and alkali works, owned by The Japanese Imperial Household.
Present position—1895 to date: Supt., The Kanto Sanso Kabushiki Kaisha (The Eastern Acid and Alkali Co., Ltd.), Oji, Japan.

Horace Reynolds Graham, Chile, S. A.
Proposed by Pope Yeatman, Reno H. Sales, J. F. Kemp, Fred Hellman.
Born 1886, New York, N. Y. Grad., Horace Mann School. 1908, Columbia Univ. School of Mines, E. M. 1907, Mucker, Timberman's Helper, etc., Vindicator mine, Cripple Creek, Colo. 1908, Fireman, Scaleman, sampler roasters; Millman, Callow tanks, Wilfley tables, vanners; 1908–09, Construction Engr., Hydro-electric plant; 1909–10, Operator, Hydro-electric plant, construction work, mill erection, reverberatory furnace, blowing engine, drafting, office mapping, test work, part inventor Watterson screen, experimental mill work; Foreman, sampling mill, mine examination, Nevada Consolidated Copper Co. 1910–11, Construction Engr.; 1911–15, Surveyor, Surface Boss, Shift Boss, Foreman, Asst. Supt., General Underground Foreman; 1915–16, Acting Mine Supt.; 1916–18, Mine Supt., Braden Copper Co., Rancagua, Chile, S. A.
Present position: General Min. Supt. and Welfare Mgr., Braden Copper Co.

William Griffiths, Anyox, B. C., Canada.
Proposed by A. J. Bone, John T. Dillon, William J. Hamilton.
Born 1884, Gorleston. 1899, Grad., Day Street British School, Hull, England. 1910–11, Sampling in concentrator, Anaconda Copper Min. Co., Great Falls, Mont. 1911–14, Sampling on converter floor, Anaconda Copper Min. Co., Great Falls, Mont.: Skimming 12-ft. basic-lined converters.
Present position—1914 to date: Smelter Statistician.

Walter Elbridge Hadley, Gary, Ind.
Proposed by Richard S. McCaffery, W. J. Mead, W. O. Hotchkiss.
Born 1882, Cambridge, Mass. 1904, Mass. Institute of Tech., S. B. 1904–05, Draftsman; 1905–06, Chemist; 1906–10, Asst. Supt., Blast Furnace, National Tube Co., McKeesport, Pa. 1910–16, Asst. Supt. and Supt., Blast Furnace, Tenn. Coal, Iron & R. R. Co. 1916–18, Pres., Trojan Electric Steel Co., Chicago, Ill.
Present position: Asst. Gen'l Supt., Gary Works, Illinois Steel Co.

Grant Holmes, Danville, Ill.
Proposed by Samuel A. Taylor, W. W. Keefer, Julius W. Hegeler.
Born 1865, Galion, Ohio. Gen'l education. 1880–84, Apprentice as mach., Huber Mfg. Co., Marion, Ohio. 1884–93, Foreman and Asst. Supt., Marion Steam Shovel Co., Marion, Ohio. 1893-1910, Mach. business, Robert Holmes & Brother,

Danville, Ill. 1910, Helped develop coal stripping shovels and methods of operation; Dir., following coal companies: Beach Flats Co., Brush Run, Ohio; Two Rivers, Carbon Hill Co., Danville, Ill.; Kehota Min. Co., Pittsburgh, Pa.
Present position—1910 to date: Pres., Robert Holmes & Bro., Inc.

Caleb Lee Horne, Muscle Shoals, Ala.
Proposed by R. E. Rightmire, Frank Haas, N. H. Emmons 2d.
Born 1888, Gold Rock, N. C. 1906, Grammer School. 1906–09, Davidson College. 1909–10, Grad., Randolph Macon College, B. S. 1910–13, Motive Power Division, Atlantic Coast Line R. R. 1913–17, Engr. of Tests, Stonega Coke & Coal Co., Big Stone Gap, Va.
Present position—1917 to date: Combustion Engr., Air Nitrates Corpn.

Arthur Hungelmann, Gary, Ind.
Proposed by Richard S. McCaffery, W. J. Mead, W. O. Hotchkiss.
Born 1880, Columbus, Ohio. 1902, Grad., Ohio State Univ., B. S. 1902–03, Analyst, Carnegie Steel Co., Duquesne, Pa. 1903, Analyst, Clairton Steel Co., Clairton, Pa. 1903–04, Asst. Chem., Sloss Sheffield Iron & Steel Co., Birmingham, Ala. 1904–05, Office of Cleveland Car Service, Cleveland, Ohio. 1905, Asst. Chem.; 1905–11, Chief Chem., Carnegie Steel Co., Columbus, Ohio.
Present position—1911 to date: Chief Met., Illinois Steel Co.

James Edward McGuire, Washington, D. C.
Proposed by A. W. Stockett, Harvey S. Mudd, Alfred G. White.
Born 1873, Grass Valley, Cal. 1881–92, Public Schools, Cal. 1894–98, Univ. of California. 1898, Grad. Univ. of California, B. S. 1899–1901, Material Clerk and Instrument Man; 1901–02, Instrument Man, Santa Fe R. R. 1902, Sampler; 1902–03, Surveyor; 1903, Shift Boss; 1903–04, Mine Foreman; 1904, Underground Mgr., Witwatersrand Deep gold mine, Johannesburg, Trans. 1904–05, Acting Mgr., Knight Central mine. 1905–06, Underground Mgr., Witwatersrand Deep Gold Min. Co., Johannesburg. 1907–09, Mine Foreman and Underground Mgr., Simmer Deep, Johannesburg. 1909, Mgr., Jupiter Gold Min., Johannesburg. 1909–11, Min. Engr., S. Neuman & Co., Rhodesia. 1912, Diamond digging. 1912–17, Mgr. of following gold mines, Johannesburg, Transvaal, S. Africa: Simmer Deep, Robinson Deep, Jupiter, Witwatersrand Deep.
Present position—1917 to date: Min. Engr., Bureau of Mines.

M. D. McIntosh, Spokane, Wash.
Proposed by L. K. Armstrong, J. McD. Porter, C. Wolfle.
Born 1867, Mt. Uniacke, N. S., High School, N. S. and U. S. 1885–92, Miner, Black Hills, S. D. 1893–1901, Shift Boss and Foreman, Golden Reward Min. Co., Deadwood, S. D. 1901–05, Shift Boss, Le Roi Min. Co., No. 2, Rossland, B. C. 1906–08, Mine Supt., British Columbia Copper Co., Greenwood, B. C. 1909–11, Min. for self, British Columbia and U. S.
Present position—1911 to date: Mine Supt., United Copper Min. Co.

Henry Sinclair McKay, Cananea, Son., Mexico.
Proposed by L. D. Ricketts, W. B. Gohring, John A. Rice.
Born 1878, Quyon, Canada. 1905, Grad., Univ. of Minnesota, E. M. 1905–07, Engr., Calumet & Arizona Min. Co., Bisbee, Ariz.
Present position—1907 to date: Supt., Democrata, Cananea, Sonora Copper Co.

William Caperton McNutt, Elk City, Idaho.
Proposed by L. K. Armstrong, J. McD. Porter, Francis A. Thomson.
Born 1862, Paint Bank, Va. 1881–82, Axman to Transitman, N. Y. C. & St. L. R. R. 1883, Transitman, B. R. & P., Pa. 1884, Preliminary survey, LaCrosse Iowa & Southwestern, Mo. and Ia. 1885–87, Asst. Engr., constr. and water supply, Chicago Burlington R. R. 1888–92, Asst. Engr., constr., charge of locating parties. 1892–97, Min. and prospecting in Ida. 1898–9, Foreman, Eureka & Pacific Placer Co., Pierce Dist., Ida. 1900, Supt., Gold Creek Min. Co., Pierce Dist. 1901, Miner and Engr., Finch & Campbell, Blue Jacket mine, Ida. 1902–05, County Surveyor. 1902–08, Engr. Office, Grangeville, Ida. 1908, Cons. Engr., Graham-Ross Co. operating Anaconda mine, Newsome Dist. 1909–10, Engr. and Supt., Golden Scale Placer Co., Elk City Dist. 1911–14, Developing personal property. 1914–16, Cons. Engr., Black Pine Min. Co.
Present position—1916 to date: Gen'l Engr. Office.

John Alexander MacCulloch, Platteville, Wis.
Proposed by Ralph E. Davis, R. J. St. Germain, W. N. Smith.
Born 1878, Northfield, Minn. 1901, Grad., Carleton College, Northfield, Minn., B. S. 1907, Grad., Univ. of Wisconsin. 1906–07, Exploration work and prospecting, Cobalt Region, Canada, for C. K. Leith, Univ. of Wisconsin, Madison, Wis. 1908–18, Zinc Min.-Operating Force, Vinegar Hill Zinc Co., Platteville, Wis.
Present position: Gen'l Supt., Vinegar Hill Zinc Co.

Clement Harold Mace, Denver, Colo.
Proposed by James M. McClave, George E. Collins, Frank Bulkley.
Born 1882, Dunlap, Ia. 1906, Grad., Univ. of California, B. S. 1906–08, Exploration Engr., Tonopah Syndicate, Tonopah, Nev. 1909, Mine Supt., Pioneer Starlight Dev. Co., Pioneer, Nev. 1910, Engr. Colorado River Hydro-electric Co.; Assayer, Surveyor, Mary Murphy Gold Min. Co., Romley, Colo. 1911–12, Field Engr., Universal Smelt. & Refin. Co., Denver, Colo. 1912, Surveyor, Arizona Copper Co., Morenci, Ariz. 1913, Smelter Supt., North Carolina Partridge Smelt. Co., Charlotte, N. C. 1914–15, Smelter Supt., Thornton Lead & Steel Corpn., Charlotte, N. C. 1915–16, Gen'l Supt., Vulcan Mines & Smelter Co., Vulcan, Colo.
Present position—1916 to date: Mgr., Technical Dept., Business Men's Clearing House.

Albert George Noellat, Victoria, Australia.
Proposed by Robert Sticht, Robert P. Roberts, Charles E. Coote.
Born 1889, Noumea, New Caledonia. 1906, Matriculated in Science, La Perhouse College, Noumea. 1912, Technical College, Sydney, N. S. W., diploma of M. E. 1912–14, Asst. in ore and metal buying dept., W. and J. Lempriere. 1914, Investigating nickel and copper prospects, later Engr., New Caledonia. 1915–16, Member of Assaying Laboratory staff, McLyell Min. & Ry. Corpn., Tasmania. 1917, Experimenting on separation of minerals in complete concentrates by leaching, flotation and magnetic separation.
Present position—1917 to date: Experimenting Met., O. T. Lempriere & Co.

José de Paiva Oliveira, Minas Geraes, Brazil.
Proposed by John C. Branner, Horace E. Williams, Jorge Belmiro de Aroujo Ferraz.
Born 1885, Itu, Estado S. Paulo, Brazil. Mackenzie College, S. Paulo, Brazil. Private tuition, London. 1909–13, Royal School of Mines Diploma, A. R. S. M., London. Imperial College of Science & Technology Diploma (D. I. C.) London. 1913-14, Cons. Min. Engr., Rio de Janeiro, Brazil. Appointed Professor of Geol., Mineralogy and Chem., Escola Superior de Agricultura, Federal Government of Brazil. 1915-18, Cons. Min. Engr.; Owner Zirconia mines, Caldas and Cascata dist., Brazil, Mining Correspondent, Bewick, Moreing & Co., London; Ridge, Beedle & Co., Glasgow, Scotland and Byington & Co., S. Paulo and New York; St., Institute Min. & Metallurgy, London.
Present position: Owner and Mgr., Zirconia and Manganese Mines, Brazil.

Frank Keehn Ovitz, Seattle, Wash.
Proposed by E. A. Holbrook, H. H. Stoek, C. M. Young.
Born 1882, Mineral Point, Wis. Mineral Point High School. 1901–05, Grad., Univ. of Michigan, B. S. 1905–06, Instr. in Chem.; 1906–07, Chem. for Engrg. Experiment Station, Univ. of Illinois, 1907–14, Asst. Chem., research on fuels, U. S. Bureau of Mines, Pittsburgh, Pa. 1914–17, Mfg. of coke and gas from Illinois coal, U. S. Bureau of Mines, Urbana, Ill. 1917–18, Fuel Engr., U. S. Bureau of Mines, Washington, D. C.
Present position: Supt., Northwest Station, Bureau of Mines.

Bhupendra nath Ray, Behar, India.
Proposed by G. H. Clevenger, W. W. Case, Jr., H. W. Young.
Born 1889, Calcutta. 1906–11, Univ. of Calcutta, B. S. 1911–12, Univ. of California. 1913–14, Leland Stanford Junior Univ., M. A. 1912–14, Joint author with G. H. Clevenger, paper entitled "The Influence of Copper upon the Physical Properties of Steel." 1917–18, Asst. Mgr., Damoderpore Colliery, Bengal Coal Co., Ltd.
Present position: Asst. Mgr., Chapui Colliery, Messrs. H. V. Low & Co.

Ralph Webster Richards, Washington, D. C.
Proposed by A. F. Lucas, David White, George Otis Smith.
Born 1879, Waterville, Me. 1901, Colby College, A. B. 1902, Tufts College, M. A. 1907–13, U. S. Geol. Survey. 1913–15, S. Pearson & Son, Ltd. 1915–16, Associated Geol. Engrs.
Present position—1916 to date: Geol., Petroleum Exploration Inc.

William Alexander Schlesinger, Denver, Colo.
Proposed by Karl L. Kithil, H. L. Brown, W. P. Cary.
Born 1886, New York, N. Y. 1907–08, School of Mines, Freiberg, Saxony. 1908–10, Univ. of Karlsruhe. 1910–12, Univ. of Heidelberg, Ph. D. 1913, Chem., Standard Chemical Co., Pittsburgh, Pa. 1913–14, Director, W. H. Schlesinger Laboratory, New York and Princeton.
Present position—1914 to date: Vice-pres. and Tech. Director, Schlesinger Radium Co.

Alexander Silverman, Pittsburgh, Pa.
Proposed by Fred L. Wolf, L. W. Olson, M. E. Wadsworth, S. L. Goodale.
Born 1881, Pittsburgh, Pa. 1902, Univ. of Pittsburgh, Ph. B.; 1907, M. S. 1905, Cornell Univ., A. B. 1902–04, Chem., Macbeth-Evans Glass Co., Pittsburgh. 1905–09, Instr. in Chem.; 1909–12, Asst. Prof.; 1912, Prof.; 1913–14, Acting Dir., Dept. of Chem., Univ. of Pittsburgh.
Present position—1914 to date: Active Head, School of Chem., Univ. of Pittsburgh.

Oliver Smalley, Northumberland, England.
Proposed by J. E. Stead, R. A. Hadfield, William Jones.
Born 1889, Chesterfield, England. Grad., Chesterfield Grammer School, Sheffield University and Bradford Technical College with diplomas. 1906–11, Asst. Chem.; 1911–13, Ch. Asst. Chem., research laboratory, Cammell Laird & Co., Ltd., Sheffield, England. 1913–14, Ch. Met. and Chem., W. Scott Engineering Co., Ltd., Bradford, England.
Present position—1914 to date: Chief Met., U. S. Research Laboratories.

George A. Stahl, Denver, Colo.
Proposed by Louis S. Noble, J. C. Roberts, Nelson Franklin.
Born 1870, Lockport, N. Y. 1888, Grad., E. Denver High School. 1888–1900, Banking in Denver. 1900–01, Asst. Sec'y, Union Gold Extraction Co., Florence, Colo. 1901–18, Asst. Sec'y, now Sec'y, and Gen'l Mgr., Vindicator Cons. Gold Min. Co. Denver, Colo. 1905–18, Sec'y, Public Ore Sampler, Eagle Ore Co., Cripple Creek, Dist. 1916–18, Sec'y, Operating Tungsten Ores, Rare Metals Ore Co., Rollinsville, Colo. 1916–18, Sec'y, Ferro Alloy Co., Denver, Colo. 1916–18 Sec'y, Black Metal Mines Co., Rollinsville, Colo.
Present position: As above.

Ward Orr Steinheimer, Herrin, Ill.
Proposed by Gilbert H. Cady, E. A. Holbrook. F. W. DeWolf.
Born 1891, Benton, Ill. Public and High School; Missouri School of Mines. 1911–13, Rodman, Putman Engrg. Co. 1914, Instrumentman, Putman & Mautz. 1915, Mgr., Mautz & Co., Herrin, Ill. 1915–17, Chief Engr., Southern Illinois Engrg. Co., Herrin, Ill.
Present position: Chief Engr., Southern Illinois Engrg. Co.

John I. Thompson, Pittsburgh, Pa.
Proposed by C. Kemble Baldwin, R. K. Stockwell, H. W. Young.
Born 1883, Braddock, Pa. 1909, Grad., Leland Stanford Jr. Univ., Cal., A. B. 1899–1905, Office Boy, Tracer, Draftsman, Machine Shop, Colorado Fuel & Iron Co., Pueblo, Colo. 1905–09, Student, Stanford Univ. 1909–10, Draftsman and Asst. to Constr. Engr., Youngstown Sheet & Tube Co., Youngstown, Ohio. 1910–12, Designer and Checker, Republic Iron & Steel Co., Youngstown, Ohio. 1912–16, Designer, Squad Leader, Asst. Chief Draftsman, Chief Draftsman, Asst. Engr., Koppers Co., Pittsburgh, Pa.
Present position—1916 to date: Chief Engr., The Koppers Co.

Walter William Weissbach, Stoddard, Ariz.
Proposed by S. E. Chaney, Horace V. Winchell, H. C. Wilmot.
Born 1886, Cincinnati, Ohio. 1907–11, Ohio State Univ. 1915–16, Grad., Rolla School of Mines, B. S. 1911–12, Engr., Carbon Block Coal Co., Cincinnati, Ohio. 1912–13, Engr. and Supt., Wagner-Azurite Copper Co., Springfield, Ohio. 1913–14, Gen'l Engrg., Greene Gold & Silver Co., Ray, Ariz. 1915–16, School, Rolla. 1916–17, Engrg. Dept., Ray Cons. Copper Co., Ray, Ariz. 1917–18, Eng., Arizona & Butte Copper Co., Ray, Ariz.
Present position: Shift Boss, Arizona Binghamton Copper Co.

George Cutler Westby, Elizabeth, N. J.
Proposed by Arthur E. Wells, A. P. Watt, Walter E. Gaby.
Born 1879, London, England. 1901, Grad., Univ. of Montana, Mech. Engrg.; Post Grad., M. S. 1901–03, Smelterman, Chem., Chief Chem., Anaconda Copper Min. Co. 1903–05, Experimental and Testing Experimental Met., Utah Cons. Min. & Smelt. Co., Murray, Utah. 1906–07, Mine Surveyor, Assayer, Twin Buttes Min. & Smelt. Co., Twin Buttes, Ariz. 1907–09, Met. testing and experimental experience, Nevada Cons. Copper Smelt. & Min. Co., Ely, Nev. 1909–11, Supt., Copper Mountain mine, Grants Pass, Ore. 1911–14, Research Met., Met., leaching plant, Nevada Cons. Smelt. & Min. Co., Ely, Nev. 1914–18, Met., Nevada Douglas Cons. Min. Co.
Present position: Met. American Smelt. Min. & Refin. Co.

Thomas A. Wetzel, Los Angeles, Cal.
Proposed by George W. Mark, T. D. Walsh, R. C. Jacobson.
Born 1881, Scandia, Kan. 1896, Public Schools, Lincoln, Nebr. 1897, Lincoln High School. 1898–99, East Denver High School. 1900–03, State Univ. of Nevada, Reno. 1904, Asst. Engr., Burlington System, St. Joseph, Mo. 1905, Worked in mines, Cripple Creek, Colo. 1906, Supt., Mt. Garms Cons. Min. Co., Mariposa Co., Cal. 1907, Supt., Five Bears Min. Co., Plumas Co., Cal. 1908, Supt., Guadalupe Mines Co., La Cumbria, Mexico. 1909–10, Mgr., So. American Gold Exploration Co., Bolivia, S. A. 1911–1912, Supt., Olla de Ow Min. Co., Ltd., La Paz Bolivia, S. A. 1913, Examination work, Ariz. 1914–15, Supt., Amalgamated Gold Min. Co. 1915–18, Examination work, Ariz.
Present position: None.

Charles H. Wheeler, Gary, Ind.
Proposed by Richard S. McCaffery, W. J. Mead, W. O. Hotchkiss, James D. Jones.
Born 1867, Alleghany City, Pa. 1885–90, Pittsburgh High School. 1890–93, Blower of Blast Furnaces, Moorhead, McLean & Co., Pittsburgh, Pa. 1893–95, Blower of Blast Furnaces, Tonawanda Iron Co. 1895–98, Engr., Buffalo St. R. R. Co., Power House, Niagara St., Buffalo. 1898–1903, Chief Engr., Buffalo School Furnace Co., Buffalo, N. Y. 1903–08, Supt. of Blast Furnace, Belfore Iron Works, Ironton, Ohio. 1908–10, Mgr., Jackson Iron & Steel Co., Jackson, Ohio.
Present position—1910 to date: Supt. of Blast Furnaces, Illinois Steel Co.

John Calvin Wilson, Los Angeles, Cal.
Proposed by J. F. Callbreath, E. H. Emerson, B. B. Lawrence.
Born 1882, Linneus, Mo. 1887-95, Public School; 1895–99, High School, Brookfield, Mo. 1902–06, American School of Correspondence. 1910–18, International Correspondence School, Scranton, Pa. 1900–01, Locomotive Fireman, C. B. & Q. R. Ry., Brookfield, Mo. 1901–03, Locomotive Fireman, Missouri Pacific Ry., Little Rock, Ark.; Atchison, Kansas; Union Pacific, Cheyenne, Wyo. 1906–08, Mech. and Boiler Maker, K. C. M. & O. Ry., Fairview, Okla. 1908–09, Engrg. constr. work, Morris & Co. and S. & S. Pkg. Co., Oklahoma City, Okla. 1909–13, Oil-field Engr. and Constr. Foreman, Magnolia Pipe Line Co., Dallas, Texas. 1913–14, Min. and shaft sinking, Pitcher Lead & Zinc Co., Baxter Springs, Kans. 1914–15, Mine Foreman and Engr., Monarch Madona Gold Min. Co., Salida, Colo. 1915–16, Min. Engr., Deitz, Wyo. 1916-17, Asst. Engr., C. F. & I. Co., Walsenburg, Colo. 1918, Asst. Engr., Cons. Coal Co., Jenkins, Ky.
Present position: Erecting Engr. and Foreman, Nitrate Plant No. 1, Sheffield, Ala.

Floyd Stephens Youtsey, St. Francois, Mo.
Proposed by A. P. Watt, C. G. Dresser, J. F. Thompson.
Born 1878, Loveland, Colo. 1894-96 and 1898, State Agri. College, Colo. 1896–98, Draftsman, Cambria Iron Co., Johnstown, Pa. 1899–1902, Draftsman, Stearns, Roger Mfg. Co., Denver, Colo. 1902–03, Draftsman, Min. Dept., Colorado Fuel & Iron Co., Denver, Colo. 1903-04, Estimator, Link Belt Co., Chicago. 1904–05, Engr., Jeffrey Mfg. Co., Chicago. 1905, Engr. in charge, conveying mach. design, Chicago, Milwaukee St. Paul R. R. 1907, Colorado Fuel & Iron Co., Denver, Colo. 1908, Engr., American Smelt. & Refin. Co.. Denver, Colo. 1909–14, Partner, Barnes & Youtsey, Denver, Colo. 1914–18, Chief Engr., Nat. Lead Co., St. Louis Branch, also cons. work.
Present position: Special work, Nat. Lead Co., St. Louis Smelt. & Refin. Co.

Associates

Carl Millard Bohner, Gary, Ind.
Proposed by Richard S. McCaffery, W. J. Mead, W. O. Hotchkiss.
Born 1890, Altoona, Pa. 1896–08, Private School, Philadelphia, Pa. 1912, Grad., Altoona High School. 1914, Ohio State Univ., Columbus, Ohio. 1918, Grad., Ohio State Univ., B. A.
Present position: Met., Gary Works, Illinois Steel Co.

George Frederick Halfacre, Palmerton, Pa.
Proposed by Carle R. Hayward, L. S. Holstein, H. O. Hofman, Charles E. Locke,
Born 1897, Boston, Mass. 1901–10, Prince School, Boston. 1910–14, English High School, Boston. 1914–18, Grad. Mass. Institute of Tech., B. S. 1917, Miner, Anaconda Copper Co., Leonard mine, Butte, Mont.
Present position: Met. Chem., New Jersey Zinc Co. (of Pa.).

Peh-Yuan Hu, Pittsburgh, Pa.
Proposed by S. L. Goodale, Robert M. Black, Roswell K. Johnson.
Born 1891, Shanghai, China. 1917, Mass. Inst. of Tech., S. B. 1918, Univ. of Pittsburgh. 1916, Summer, coal mine, Pittsburgh Rochester & Baltimore Coal & Iron Co., Indiana, Pa. 1917, Summer, Asst. Oil Geol., Oil Fields, Ky. 1918, Steam and Hydraulic Dept. Blast Furnace, National Tube Co., McKeesport, Pa.
Present position: Met. Dept., Jones & Laughlin Steel Co.

Thomas Henry Noon, Colorado Springs, Colo.
Proposed by J. A. Ede, E. A. Holbrook, H. W. Nichols.
Born 1891, Peru, Ill. 1905–08, St. Bedes College, Ill. 1908–11, St. Marys College, Kans. 1911–15, Marquette Univ., Milwaukee, Wis., B. S. 1908–15, Summers, Illinois Zinc Co., Peru, Ill. 1915–16, Draftsman, United Engrg. & Foundry Co., Pittsburgh office. 1916–18, Colorado Springs, seeking health.
Present position: None.

Junior Associates

Blair Burwell, Golden, Colo.
Proposed by J. C. Roberts, Victor C. Alderson, I. A. Palmer.
Born 1898, Durango, Colo. 1909–13, Durango High School. 1913–14, Univ. o[f] Denver, Denver, Colo. 1916–18, Colorado School of Mines, Golden, Colo. 1908–1[…] Summers, Rodman and Levelman, under my father, surveying work and irrigati[on] projects. 1914, Topographer, W. I. Hoklas, Steamboat Springs, Colo. 1915–1[…] Accnt., M. Caffery Wholesale Merc. Co., Denver, Colo.
Present position—1916 to date: Student, Colorado School of Mines.

Eugene Hendel Hicks, Golden, Colo.
Proposed by J. C. Roberts, I. A. Palmer, Victor C. Alderson.
Born 1900, Lasalle. Ill. 1906–12, Central High School, St. Paul, Minn. 1912– Colorado School of Mines. 1918, 3 mo., Minn. By-product Coke Co. Lab.
Present position—1917 to date: Student, Colorado School of Mines.

George Morton Kintz, Denver, Colo.
Proposed by J. C. Roberts, Victor C. Alderson, I. A. Palmer.
Born 1897, Colorado Springs, Colo. 1912–14, North Side High School, De[nver,] Colo. 1914–16, Manual Training High, Denver, Colo. 1916–17, Universit[y of] Colorado, Boulder, Colo.
Present position—1917 to date: Student, Colorado School of Mines.

John Samson Surfluh, Golden, Colo.
Proposed by Victor C. Alderson, J. C. Roberts, I. A. Palmer.
Born 1898, Cottonwood Falls, Kan. 1913–17, Lincoln High School, Los An[geles,] Cal.
Present position—1917 to date: Student, Colorado School of Mines.

Frederic G. Sefing, So. Bethlehem, Pa.
Proposed by Joseph W. Richards, Howard Eckfeldt, Benjamin L. Miller.
Born 1898, Allentown, Pa. 1911–13, Allentown High School. 1913–15, Bethl[ehem] Prep. School. 1915, Lehigh Univ. 1917, Summer, chem. lab., New Jersey Zin[c …] 1918, Summer, sampling, Great Falls Reduction Dept., Anaconda Copper Min[…]
Present position: Student, Lehigh Univ.

Change of Status—From Associate to Member

Girard B. Rosenblatt, Salt Lake City, Utah.

Proposed by Ernest Gayford, C. W. Goodale, D. A. Lyon.

Born 1881, New York City. 1890–98, Collegiate Inst. 1898–1902, Grad., Columbia Univ., E. E. 1902–03, Apprenticeship Course; 1903, Testing Dept.; 1904–05, Engrg. Dept., Westinghouse Electric & Mfg. Co. 1905, Various investigations, Otis Elevator Co., Brooklyn Rapid Transit Co., United Electric Light & Power Co. of Baltimore. 1906–12, Charge, Butte office, Westinghouse Electric & Mfg. Co. 1912–18, Engr. in charge of min. work for Westinghouse Electric & Mfg. Co. for territory west of Miss. River including Alaska. In this position, the writer is responsible for the success of plant layouts and the application of electrical apparatus to the min. & met. industries of the West. He has had charge of the electrical design of a very considerable number of hoisting plants, concentrating mills and some electro-met. plants. The design of considerable electrical apparatus especially used for met. process has been under his guidance. Has been engaged in and directed research work on the Cottrell process, electrolytic copper refining, etc., for about three years.

Present position: As above.

STANDING COMMITTEES

Executive

SIDNEY J. JENNINGS, *Chairman*

GEORGE D. BARRON
EDWIN LUDLOW
J. E. JOHNSON, JR.
ROBERT M. RAYMOND

Membership

KARL EILERS, *Chairman*

LEWIS W. FRANCIS
LOUIS D. HUNTOON
J. E. JOHNSON, JR.
ARTHUR L. WALKER

Finance

GEORGE D. BARRON, *Chairman*

CHARLES F. RAND
BENJAMIN B. THAYER

Library

E. GYBBON SPILSBURY,[1] *Chairman*

ALEX C. HUMPHREYS[2]
J. H. JANEWAY[4]
GEORGE C. STONE[3]
BRADLEY STOUGHTON

Papers and Publications

BRADLEY STOUGHTON, *Chairman*

EXECUTIVE COMMITTEE

PERCY E. BARBOUR
WILLIAM A. COWAN
H. C. PARMELEE
THOMAS T. READ
JOSEPH W. RICHARDS
GEORGE C. STONE
SAMUEL A. TAYLOR

J. L. W. BIRKINBINE
WILLIAM H. BLAUVELT
H. A. BRASSERT
WILLIAM CAMPBELL
R. M. CATLIN
ALLAN J. CLARK
FREDERICK G. COTTRELL
KARL EILERS
NATHANIEL H. EMMONS
JOHN W. FINCH
CHARLES H. FULTON
F. LYNWOOD GARRISON
ROBERT C. GEMMELL
H. W. GILLETT
CHARLES W. GOODALE
HARRY A. GUESS
R. DAWSON HALL
PHILIP W. HENRY
HEINRICH O. HOFMAN
WALTER E. HOPPER
HENRY M. HOWE
LOUIS D. HUNTOON
J. E. JOHNSON, JR.
WILLIAM KELLY
JAMES F. KEMP
CHARLES K. LEITH
ANTHONY F. LUCAS
EDWARD P. MATHEWSON
HERBERT A. MEGRAW
PAUL D. MERICA
RICHARD MOLDENKE
SEELEY W. MUDD
R. V. NORRIS
EDWARD W. PARKER
NATHANIEL K. B. PATCH
R. M. RAYMOND
ROSSITER W. RAYMOND
ROBERT H. RICHARDS
L. D. RICKETTS
HEINRICH RIES
RENO H. SALES
ALBERT SAUVEUR
HENRY L. SMYTH
A. A. STEVENSON
RALPH H. SWEETSER
GEORGE D. VAN ARSDALE
ARTHUR L. WALKER
ROLLA B. WATSON
HORACE V. WINCHELL
FREDERICK W. WOOD
DWIGHT E. WOODBRIDGE

Nominations

R. V. NORRIS, *Chairman*

WALTER H. ALDRIDGE
WALTER DOUGLAS
D. W. BRUNTON
C. H. MACDOWELL
C. W. WHITLEY

Institute of Metals Division

WILLIAM M. CORSE, *Chairman*
FRED L. WOLF, *Secretary*, Ohio Brass Co., Mansfield, Ohio

EXECUTIVE COMMITTEES OF LOCAL SECTIONS

New York

Meets first Wednesday after first Tuesday of each month.

ALLEN H. ROGERS, *Chairman*
H. C. PARMELEE, *Vice-chairman*
FOREST RUTHERFORD, *Vice-chairman*
W. S. DICKSON, *Secretary*, 71 Broadway, New York, N. Y.
J. E. JOHNSON, JR.
F. T. RUBIDGE
P. G. SPILSBURY

Boston

Meets first Monday of each winter month.

ALFRED C. LANE, *Chairman*
G. A. PACKARD, *Vice-chairman*
E. E. BUGBEE, *Secretary-Treasurer*, Mass. Inst. of Technology, Cambridge, Mass.
R. L. AGASSIZ
FRED W. DENTON

Columbia

Holds four sessions during year. Annual meeting in September or October.

S. S. FOWLER, *Chairman*
J. C. HAAS, *Vice-chairman*
LYNDON K. ARMSTRONG, *Secretary-Treasurer*, 720 Peyton Bldg., Spokane, Wash.
W. H. LINNEY
J. F. McCARTHY

---

[1] Until Feb., 1919. [2] Until Feb., 1920 [3] Until Feb., 1921. [4] Until Feb., 1922.

Puget Sound

Meets second Saturday of each month.

HENRY LANDES, *Chairman* GEORGE E. ROCKEFELLER, *Vice-chairman*
PERCY E. WRIGHT, *Secretary-Treasurer*, 2012 L. C. Smith Bldg., Seattle, Wash.
SIMON H. ASH. CHARLES SIMENSTAD

Southern California

RALPH ARNOLD, *Chairman* WILLIAM F. STAUNTON, *Vice-chairman*
ALVIN B. CARPENTER, *Secretary-Treasurer*, 530 Citizens National Bank Bldg., Los Angeles, Cal.
A. B. W. HODGES LESLIE C. MOTT
C. COLCOCK JONES JAMES W. NEILL

Colorado

CHARLES M. MACNEILL, *Chairman* GEORGE M. TAYLOR, *Vice-chairman*
FRED CARROLL, *Secretary-Treasurer*, State Capitol, Denver, Colo.
W. W. CASE H. E. COLLBRAN

Montana

N. B. BRALY, *Chairman* B. H. DUNSHEE, *Vice-chairman*
E. B. YOUNG, *Secretary-Treasurer*, 526 Hennesy Building, Butte, Mont.
F. W. BACORN C. D. DEMOND

San Francisco

Meets second Tuesday of each month.

A. C. LAWSON, *Chairman* ROY H. ELLIOTT, *Vice-chairman*
W. H. SHOCKLEY, *Secretary-Treasurer*, 959 Waverley St., Palo Alto, Cal.
T. A. RICKARD C. F. TOLMAN, JR.

Pennsylvania Anthracite

R. V. NORRIS, *Chairman*
CHARLES F. HUBER, *Vice-chairman* EDWIN LUDLOW, *Vice-chairman*
W. J. RICHARDS, *Vice-chairman* ARTHUR H. STORRS, *Vice-chairman*
PAUL STERLING, *Secretary-Treasurer*, Lehigh Valley Coal Co., Wilkes-Barre, Pa.
DOUGLAS BUNTING W. W. INGLIS HENRY W. MONTZ
JOHN M. HUMPHREY EDWARD E. KAERCHER ROBERT A. QUIN

St. Louis

EUGENE McAULIFFE, *Chairman* J. N. HOUSER, *Vice-chairman*
VICTOR RAKOWSKY, *Vice-chairman* H. G. WASHBURN, *Vice-chairman*
WALTER E. McCOURT, *Secretary-Treasurer*, Washington Univ., St. Louis, Mo.
H. A. BUEHLER G. H. COX L. C. GLENN
E. A. HOLBROOK W. E. NEWNAM

Chicago

CHARLES H. MACDOWELL, *Chairman* LUTHER V. RICE, *Vice-chairman*
HENRY W. NICHOLS, *Secretary-Treasurer*, Field Museum of Natural History, Chicago, Ill.
ALEXANDER K. HAMILTON G. P. HULST
HENRY P. HOWLAND FREDERICK T. SNYDER

Utah

WILLIAM WRAITH, *Chairman* CECIL FITCH, *Vice-chairman*
F. G. MOSES, *Secretary-Treasurer*, University of Utah, Salt Lake City, Utah.
ERNEST GAYFORD E. R. ZALINSKI

Arizona

L. O. HOWARD, *Chairman*
NORMAN CARMICHAEL, *1st Vice-chairman* J. C. GREENWAY, *2d Vice-chairman*
H. L. NORTON, *Secretary-Treasurer*, Globe, Ariz.
L. S. CATES F. W. MACLENNAN R. E. TALLY

Nevada

R. E. H. POMEROY, *Chairman* J. C. JONES, *Vice-chairman*
HENRY M. RIVES, *Secretary-Treasurer*, 210 Reno National Bank Bldg., Reno, Nev.
W. H. BLACKBURN FREDERICK BRADSHAW C. B. LAKENAN
EMMET D. BOYLE J. W. HUTCHINSON WHITMAN SYMMES
JOHN G. KIRCHEN

Mexico

(Instituto Mexicano de Minas y Metalurgia)

VICTOR M. BRASCHI, *Chairman*, Committee on Organization

Tulsa

ALF. G. HEGGEM, *Chairman* ALEXANDER DEUSSEN, *Vice-chairman*
CHARLES H. TAYLOR, *Vice-chairman*
M. M. VALERIUS, *Junior Vice-chairman* ERASMUS HAWORTH, *Vice-chairman*
JAMES H. GARDNER, *Secretary-Treasurer*, Tulsa, Okla.
IRVING PERRINE J. J. RUTLEDGE S. H. WORRELL

Washington, D. C.

HERBERT C. HOOVER, *Chairman*

H. FOSTER BAIN, *Vice-chairman* DAVID WHITE, *Vice-chairman*

HARVEY S. MUDD, *Secretary-Treasurer*, Room 2114, Dept. of Interior Bldg.

J. F. CALLBREATH HENNEN JENNINGS E. W. PARKER T. T. READ

COMMITTEE ON JUNIOR MEMBERS AND AFFILIATED STUDENT SOCIETIES

CHARLES H. FULTON, *Chairman*

Vice-chairmen

EDWIN C. HOLDEN GEORGE J. YOUNG
FREDERICK W. SPERR

WALTER R. CRANE, *Secretary*, Pennsylvania State College, State College, Pa.

LUTHER W. BAHNEY
DARSIE C. BARD
ROBERT H. BRADFORD
SAMUEL W. BEYER
GUY H. COX
JOSEPH DANIELS
NOAH F. DRAKE
FRANK W. DURKEE
HOWARD ECKFELDT
DAVID M. FOLSOM
R. R. GOODRICH
CHARLES E. LOCKE
JAMES F. McCLELLAND
HARRY B. MELLER
WALTER S. MORLEY
HENRY S. MUNROE
CHARLES J. NORWOOD
H. C. PARMELEE
GEORGE S. RAYMER
HEINRICH RIES
HENRY L. SMYTH
HARRY H. STOEK
FRANCIS A. THOMSON
CLINTON M. YOUNG

COMMITTEE ON INCREASE OF MEMBERSHIP

J. V. N. DORR, *Chairman*

FOREST RUTHERFORD, *First Vice-chairman*

H. C. PARMELEE, *Secretary*, *Chem. & Met. Eng.*, 10th Ave. & 36th St., New York, N. Y.

Vice-chairmen

L. K. ARMSTRONG
C. H. BENEDICT
ELI T. CONNER
DORSEY HAGER
G. P. HULST
P. M. McHUGH
H. L. WILLIAMS
DWIGHT E. WOODBRIDGE
R. B. WOODWORTH

Committee

FRANK L. ANTISELL
C. E. ARNOLD
FRANKLIN BACHE
D. C. BARD
LOUIS V. BENDER
SAMUEL W. BEYER
NORMAN B. BRALY
G. S. BROOKS
ALAN BRUYERE
FRANK BULKLEY
FRED CARROLL
THOMAS H. CLAGETT
G. M. COLVOCORESSES
ARTHUR CROWFOOT
H. W. DU BOIS
J. A. EDE
L. V. EMANUEL
NEWTON W. EMMENS
J. N. ESSELSTYN
ERNEST GAYFORD
CHARLES N. GOULD
H. W. HARDINGE
ENOCH HENDERSON
HERBERT B. HENEGAR
FRANK R. HEWITT
JOSEPH T. HILLES
C. B. HOLLIS
T. A. JANNEY
ZAY JEFFRIES
OLAF P. JENKINS
FRANK G. JEWETT
ARTHUR G. JOHNSON
F. F. JORGENSEN
C. B. LAKENAN
LEONARD LARSON
E. T. LEDNUM
CHARLES LEGRAND
EUGENE McAULIFFE
ROBERT McCART, Jr.
JOHN H. McCHRYSTAL
W. E. McCOURT
V. H. McNUTT
T. W. MATHER
E. P. MATHEWSON
T. POOLE MAYNARD
H. W. MORSE
HENRY W. NICHOLS
C. C. O'HARRA
FRANK H. PROBERT
JOSEPH W. RICHARDS
OTTO RISSMANN
W. W. ROSE
FRANK L. SIZER
LEWIS STOCKETT
WALTER G. SWART
ARTHUR M. SWARTLEY
ARTHUR F. TAGGART
JOHN C. TAYLOR
WILLIAM D. WALTMAN
JESSE B. WARRINER
E. R. WASH
W. Y. WESTERVELT
F. R. WICKES
BERKELEY WILLIAMS

INSTITUTE REPRESENTATIVES

United Engineering Society Trustees

CHARLES F. RAND[2] W. L. SAUNDERS[1] BENJAMIN B. THAYER[1]

Engineering Foundation

R. M. RAYMOND[1] J. W. RICHARDS BENJAMIN B. THAYER[3]

Library Board, United Engineering Society

ALEX C. HUMPHREYS[3] E. GYBBON SPILSBURY[1]
J. H. JANEWAY[4] BRADLEY STOUGHTON GEORGE C. STONE[3]

John Fritz Medal Board of Award

C. R. CORNING[2] E. GYBBON SPILSBURY[4]
CHARLES F. RAND[1] BENJAMIN B. THAYER[3]

Engineering Council

J. PARKE CHANNING[3] B. B. LAWRENCE[1]
S. J. JENNINGS[1] P. N. MOORE[2] EDWIN LUDLOW[2]

American Association for the Advancement of Science

WALDEMAR LINDGREN JOSEPH B. TYRRELL

Committee on Standardization of Graphical Methods

JUDD STEWART

Joint Committee on War Minerals

WILLIAM Y. WESTERVELT

Committee on Mining Law Revision

JAMES R. FINLAY HENNEN JENNINGS
D. C. JACKLING EDMUND B. KIRBY C. F. KELLEY

National Research Council

P. N. MOORE

Naval Consulting Board

Members

WILLIAM L. SAUNDERS BENJAMIN B. THAYER

Associate Members

STEPHEN O. ANDROS
E. J. BABCOCK
H. R. BATCHELLER
PHILIP R. BRADLEY
J. L. BRUCE
D. W. BRUNTON
ALLAN J. CLARK
F. K. COPELAND
B. F. CRESSON, JR.
ROBERT N. DICKMAN
M. M. DUNCAN
T. C. DU PONT
STANLY A. EASTON
W. E. C. EUSTIS
J. R. FORDYCE
FRANK B. GEARHART
J. C. GREENWAY
LAFAYETTE HANCHETT
C. B. HOLLIS
GEORGE P. HULST
FRANK U. HUMBERT
HENNEN JENNINGS
S. W. McCALLIE
A. J. McQUATTERS
C. W. MERRILL
P. N. MOORE
F. W. O'NEIL
WALTER T. PAGE
W. H. PEIRCE
JOSEPH H. PRATT
H. V. WINCHELL
J. C. RALSTON
CHARLES F. RAND
FRANK D. RASH
R. H. RICHARDS
C. S. ROBINSON
WALTER M. SAUNDERS
E. A. SAYRE
H. L. SCAIFE
A. M. SWARTLEY
PRIESTLEY TOULMIN
W. E. TRENT
M. M. VALERIUS
W. D. WALTMAN
I. C. WHITE
ELI WHITNEY

Committee on Engineering Education

JOHN HAYS HAMMOND HENRY MARION HOWE

Conference Committee on Proposed Adoption of Metric System

GEORGE F. KUNZ JOSEPH W. RICHARDS

Joseph A. Holmes Safety Association

HENNEN JENNINGS

Joint Conference Committee on American Engineering Standards

J. W. RICHARDS G. C. STONE ARTHUR L. WALKER

Joint Committee on Water Power Development

H. HOBART PORTER

Washington Medal Commission of Award

ROBERT W. HUNT[2] CHARLES H. MACDOWELL[1]

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921. [4] Until Feb., 1922.

Pan-American Engineering Committee

WALTER H. ALDRIDGE
FREDERICK K. COPELAND
JOSEPH W. RICHARDS
W. H. LEONARD
P. N. MOORE

Committee on Military Engineering of New York

J. PARKE CHANNING
ARTHUR S. DWIGHT
ALEX C. HUMPHREYS
CHARLES F. RAND
L. D. RICKETTS
WILLIAM L. SAUNDERS
BRADLEY STOUGHTON
WILLIAM H. WILEY

COMMITTEE ADVISORY TO THE U. S. BUREAU OF MINES

ARTHUR F. L. BELL
HENNEN JENNINGS
ALBERT R. LEDOUX
E. W. PARKER
L. D. RICKETTS

Electricity in Mining
WILLIAM KELLY
THOMAS H. LEGGETT
SAMUEL A. TAYLOR

Mine Explosions
H. M. CHANCE
FRANK HAAS
CARL SCHOLZ

Mine Subsidence
JAMES F. KEMP
R. V. NORRIS
CHARLES K. LEITH

COMMITTEE ADVISORY TO THE U. S. BUREAU OF STANDARDS

Copper: F. L. ANTISELL
Lead: ARTHUR S. DWIGHT
Nickel: JOHN F. THOMPSON
Aluminum: JOSEPH W. RICHARDS
Zinc: GEORGE C. STONE

COMMITTEE ADVISORY TO THE U. S. TARIFF COMMISSION

Ferrous Metals
J. E. JOHNSON, JR.
H. D. HIBBARD
RICHARD PETERS, JR.

Non-ferrous Metals
HERMAN GARLICHS
F. LYNWOOD GARRISON
FOREST RUTHERFORD

WAR MINERALS COMMITTEE

WILLIAM YOUNG WESTERVELT, *Chairman,*
Representing A. I. M. E., and M. and M. Soc. of Am.
ALFRED G. WHITE, *Secretary,*
Representing U. S. Bureau of Mines
W. O. HOTCHKISS,
Representing Association of American State Geologists
DAVID WHITE,
Representing U. S. Geological Survey
HARVEY S. MUDD, *Asst. Secretary*

Associate Members from the A. I. M. E.

H. A. BUEHLER
FRED CARROLL
N. F. DRAKE
R. D. GEORGE
E. A. HOLBROOK
EDWIN LUDLOW
S. W. McCALLIE
WILLET G. MILLER
EDMUND NEWTON
H. L. NORTON
WILLIAM C. PHALEN
T. A. RICKARD
CHARLES SIMENSTAD
H. H. STOEK
JOSEPH H. TAYLOR
ARTHUR L. WALKER
THOMAS L. WATSON
E. B. YOUNG

TECHNICAL COMMITTEES

Iron and Steel

JOSEPH W. RICHARDS, *Chairman*, Lehigh Univ., So. Bethlehem, Pa.
J. E. JOHNSON, JR., *Vice-chairman*

SUB-COMMITTEES

IRON ORE

DWIGHT E. WOODBRIDGE, *Chairman*
ERNEST F. BURCHARD — WILLIAM KELLY — CHARLES F. RAND

BLAST FURNACES

H. A. BRASSERT, *Chairman*
WILLIAM H. BLAUVELT — AMBROSE N. DIEHL — JAMES GAYLEY
RICHARD V. McKAY

STEEL WORKS

HENRY D. HIBBARD, *Chairman*
GUILLIAEM AERTSEN — C. F. W. RYS — J. S. UNGER
FRANK D. CARNEY — WILLIAM R. WALKER

MECHANICAL TREATMENT

A. A. STEVENSON, *Chairman*
CHARLES A. BUCK — ROBERT W. HUNT — FREDERICK W. WOOD
GEORGE MESTA

FOUNDRY

RICHARD MOLDENKE, *Chairman*
JOHN H. HALL — ENRIQUE TOUCEDA

CHEMISTRY, PHYSICS, AND METALLOGRAPHY

HERBERT M. BOYLSTON, *Chairman*
WILLIAM CAMPBELL — JOHN A. MATHEWS — ALBERT SAUVEUR
HENRY M. HOWE — E. GYBBON SPILSBURY — LEONARD WALDO
WILLIAM R. WEBSTER

Petroleum and Gas

ANTHONY F. LUCAS, *Chairman*
MARK L. REQUA, *First Vice-chairman*
ISAAC N. KNAPP, *Secretary*
RALPH ARNOLD, *Vice-chairman* — LEONARD WALDO, *Vice-chairman*
WILLIAM N. BEST, *Vice-chairman* — DAVID WHITE, *Vice-chairman*
EDWIN T. DUMBLE, *Vice-chairman* — I. C. WHITE, *Vice-chairman*
JAMES F. KEMP, *Vice-chairman*

ARTHUR F. L. BELL — JOHN R. EDWARDS — EZEQUIEL ORDONEZ
FREDERICK G. CLAPP — JAMES H. GARDNER — M. M. VALERIUS
EUGENE COSTE — DORSEY HAGER — CHESTER W. WASHBURNE
DAVID T. DAY — ALFRED G. HEGGEM — HERBERT A. WHEELER
ALEXANDER DEUSSEN — L. L. HUTCHISON — W. E. WRATHER

Coal and Coke

SAMUEL A. TAYLOR, *Chairman*
EDWIN LUDLOW, *Vice-chairman* — W. J. RICHARDS, *Vice-chairman*
FREDERICK W. C. WHYTE, *Vice-chairman* — H. H. STOEK, *Vice-chairman*
WILLIAM E. FOHL, *Secretary*, Farmers' Bank Bldg., Pittsburgh, Pa.

S. B. BELDEN — R. DAWSON HALL — FRANK A. RAY
WILLIAM H. BLAUVELT — FRANK ALBERT HILL — THOMAS H. O'BRIEN
H. M. CHANCE — CHARLES F. HUBER — GEORGE S. RICE
THOMAS H. CLAGETT — JAMES ELLWOOD JONES — JOHN J. RUTLEDGE
ELI T. CONNER — CHARLES E. KREBS — CARL SCHOLZ
JAMES S. CUNNINGHAM — GEORGE J. KREBS — JOHN ROY SHARP
E. V. D'INVILLIERS — A. C. LEISENRING — T. W. SPRAGUE
W. W. DUFFIELD — SPENCER R. LOGAN — ARTHUR H. STORRS
HOWARD N. EAVENSON — EUGENE McAULIFFE — ISRAEL C. WHITE
CHARLES ENZIAN — CHARLES T. MALCOLMSON — WILLIAM G. WILKINS
WILLIAM A. FORBES — FRANK A. MANLEY — LEWIS L. WILLARD
WILLIAM H. GRADY — R. V. NORRIS — CLINTON M. YOUNG
FRANK HAAS — CHARLES J. NORWOOD

Precious and Base Metals

CHARLES W. GOODALE, *Chairman*
ARTHUR L. WALKER, *Vice-chairman* ROBERT C. GEMMELL, *Vice-chairman*
DARSIE C. BARD, *Secretary*, Montana State School of Mines, Butte, Mont.

SUB-COMMITTEES

COPPER

EDWARD P. MATHEWSON, *Chairman*

LAWRENCE ADDICKS
W. LAWRENCE AUSTIN
JOHN C. GREENWAY
LAFAYETTE HANCHETT
L. OGILVIE HOWARD
FREDERICK LAIST
C. B. LAKENAN
GEORGE W. METCALFE
L. D. RICKETTS
FOREST RUTHERFORD
GEORGE D. VAN ARSDALE
ARTHUR L. WALKER
ARCHER E. WHEELER
ALBERT E. WIGGIN

GOLD AND SILVER

F. LYNWOOD GARRISON, *Chairman*

F. L. BOSQUI
PHILIP R. BRADLEY
CHARLES BUTTERS
ROBERT C. CANBY
ALLAN J. CLARK
GEORGE H. CLEVENGER
HARRY S. DENNY
JOHN V. N. DORR
CHARLES W. MERRILL
WILLET G. MILLER
CHARLES H. MUNRO
R. M. RAYMOND
WHITMAN SYMMES

LEAD

HEINRICH O. HOFMAN, *Chairman*

C. J. ADAMI
LEONARD S. AUSTIN
WILLIAM BRADEN
ARTHUR S. DWIGHT
KARL EILERS
HERMAN GARLICHS
ERNEST A. HERSAM
G. P. HULST
SIDNEY J. JENNINGS
FRANK M. SMITH
WILLIAM A. SMITH
FREDERIC R. WEEKES
RUSH J. WHITE
C. W. WHITLEY
WILLIAM WRAITH

ZINC

GEORGE C. STONE, *Chairman*

S. E. BRETHERTON
GELASIO CAETANI
C. A. H. DESAULLES
H. W. GEPP
W. McA. JOHNSON
FREDERICK LAIST
DORSEY A. LYON
OTTO RISSMAN
C. E. SIEBENTHAL

MISCELLANEOUS METALS

CHARLES H. FULTON, *Chairman*

SIEGFRIED FISCHER
FRANK L. HESS
ZAY JEFFRIES
ROBERT M. KEENEY
GEORGE A. PACKARD
WALTER M. STEIN
JOSEPH STRUTHERS
WILLIS R. WHITNEY

PLACER DEPOSITS

CHARLES JANIN, *Chairman*

MARK N. ALLING
SIDNEY H. BALL
PIERRE BOUERY
C. C. BRAYTON
NEWTON CLEAVELAND
ROBERT E. CRANSTON
F. LYNWOOD GARRISON
J. J. HAMLYN
W. P. HAMMON
ROSS B. HOFFMANN
HENNEN JENNINGS
E. B. KIMBALL
CHESTER F. LEE
H. L. MEAD
F. L. MORRIS
C. H. MUNRO
WILLIAM S. NOYES
HENRY C. PERKINS
O. B. PERRY

Non-metallic Minerals

HEINRICH RIES, *Chairman*
CHARLES P. BERKEY, *Vice-chairman* GEORGE F. KUNZ, *Vice-chairman*
EDWARD W. PARKER, *Vice-chairman*
WILLIAM C. PHALEN, *Secretary*, U. S. Bureau of Mines, Washington, D. C.

SAMUEL W. BEYER
H. A. BUEHLER
JOHN A. DRESSER
R. D. GEORGE
FRANK L. HESS
F. R. HEWITT
F. C. HOOPER
C. COLCOCK JONES
C. G. MEMMINGER
BENJAMIN L. MILLER
WILLET G. MILLER
JOSEPH HYDE PRATT
KENNETH SEAVER
THOMAS L. WATSON

Mining Geology

JOHN W. FINCH, *Vice-chairman*
L. C. GRATON, *Secretary*, Harvard Geological Museum, Cambridge, Mass.

RALPH ARNOLD	IRA B. JORALEMON	R. A. F. PENROSE, Jr.
JOHN M. BOUTWELL	JAMES F. KEMP	JOSEPH HYDE PRATT
H. A. BUEHLER	HENRY LANDES	HEINRICH RIES
MARIUS R. CAMPBELL	ALFRED C. LANE	RENO H. SALES
C. R. CORNING	CHARLES K. LEITH	WILLIAM G. SHARP
M. J. ELSING	R. V. NORRIS	HENRY L. SMYTH
WILLIAM H. EMMONS	ARTHUR NOTMAN	JOSIAH E. SPURR
F. LYNWOOD GARRISON	EZEQUIEL ORDOÑEZ	M. E. WADSWORTH

Mining Methods

ROBERT M. CATLIN, *Chairman*
BENJAMIN F. TILLSON, *Secretary*, Franklin Furnace, N. J.

TRUMAN H. ALDRICH, JR.	JOHN GILLIE	MILNOR ROBERTS
HANS C. BEHR	WILLIAM L. HONNOLD	OSCAR ROHN
R. B. BRINSMADE	JAMES E. JOPLING	GERALD SHERMAN
DOUGLAS BUNTING	ROBERT A. KINZIE	HENRY L. SMYTH
LOUIS S. CATES	HENRY KRUMB	BENJAMIN W. VALLAT
CHARLES CATLETT	WILLIAM H. LEONARD	RUEL C. WARRINER
FRED W. DENTON	HENRY LOUIS	SAMUEL D. WARRINER
STANLY A. EASTON	JAMES F. McCLELLAND	GEORGE WEIR
JAMES R. FINLAY	SEELEY W. MUDD	DWIGHT E. WOODBRIDGE
R. C. GEMMELL	JAMES B. RISQUE	

Milling Methods

ROBERT H. RICHARDS, *Chairman*
CHARLES E. LOCKE, *Secretary*, Mass. Institute of Technology, Boston, Mass.

EARL S. BARDWELL	RUDOLF GAHL	JOHN B. PORTER
H. K. BURCH	H. A. GUESS	LEWIS G. ROWAND
CHARLES BUTTERS	H. C. HOOVER	E. A. C. SMITH
GELASIO CAETANI	FREDERICK LAIST	T. B. STEARNS
WILLIAM A. CALDECOTT	C. B. LAKENAN	WALTER G. SWART
JOHN M. CALLOW	W. P. LASS	ARTHUR THACHER
CHARLES A. CHASE	CHARLES W. MERRILL	A. P. WATT
DAVID COLE	HENRY S. MUNROE	BULKELEY WELLS
JOHN V. N. DORR	E. H. NUTTER	ALBERT E. WIGGIN
ARTHUR S. DWIGHT	C. Q. PAYNE	GEORGE H. WYMAN, JR.

Mining Law

CORNELIUS F. KELLEY, *Chairman*
JOHN W. FINCH, *Vice-chairman* CURTIS H. LINDLEY, *Vice-chairman*

ALBERT BURCH	CHARLES W. GOODALE	CHARLES H. SHAMEL
J. MURRAY CLARK	EDWIN O. HOLTER	FRANK L. SIZER
WILL L. CLARK	EDMUND B. KIRBY	WALTER H. WILEY
C. LORIMER COLBURN	MARK L. REQUA	HORACE V. WINCHELL
COURTENAY DEKALB	WILLIAM SCALLON	

The Use of Electricity in Mines

WILLIAM KELLY, *Chairman*

FRANCIS O. BLACKWELL	JOHN LANGTON	DAVID B. RUSHMORE
GRAHAM BRIGHT	CHARLES LEGRAND	HARRY M. WARREN
F. K. COPELAND	FREDERICK W. O'NEIL	GEORGE R. WOOD
OZNI P. HOOD	STEPHEN H. PITKIN	

Industrial Organization

T. T. READ, *Chairman*

NEWELL G. ALFORD
E. E. BACH
F. M. BARNES
WILLIAM L. BELL
W. O. BORCHERDT
PHILIP R. BRADLEY
WILLIAM L. CLARK
GEORGE G. CRAWFORD
H. G. DAVIS
R. W. DEACON
M. M. DUNCAN
HOWARD N. EAVENSON
CHARLES T. FAIRBAIRN
CHARLES W. GOODALE
EDWIN HIGGINS
R. DAWSON HALL
C. R. HOOK
HENNEN JENNINGS
CORNELIUS B. LAKENAN
JOHN LANGTON
A. P. LANZA
JOHN LLOYD
J. W. PAUL
JAMES B. RISQUE
J. C. ROBERTS
BURR A. ROBINSON
CARL SCHOLZ
L. A. SHOUDY
FRANCIS P. SINN
WILLIAM ALLEN SMITH
BENJAMIN F. TILLSON
W. G. WHILDIN
ARTHUR WILLIAMS
H. M. WILSON
H. M. WOLFLIN
DWIGHT E. WOODBRIDGE
H. I. YOUNG

SUB-COMMITTEE ON AMERICANIZATION

HENNEN JENNINGS, *Chairman* CORNELIUS B. LAKENAN JAMES B. RÍSQUE
(To coöperate with National Americanization Committee)

SUB-COMMITTEE ON CRIPPLES IN INDUSTRY

B. A. ROBINSON, *Chairman* NEWELL G. ALFORD EDWIN HIGGINS
(To coöperate with the Surgeon General, U. S. A., and the Red Cross Institute)

SUB-COMMITTEE ON EDUCATION

E. E. BACH, *Chairman* M. M. DUNCAN J. C. ROBERTS
(To coöperate with National Association of Corporation Schools)

SUB-COMMITTEE ON EMPLOYMENT

H. M. WILSON, *Chairman* WILLIAM L. CLARK WILLIAM ALLEN SMITH
(To coöperate with U. S. Department of Labor)

SUB-COMMITTEE ON HOUSING

C. R. HOOK, *Chairman* JOHN LANGTON W. G. WHILDIN
(To coöperate with National Housing Association, and U. S. Dept. of Labor)

SUB-COMMITTEE ON MENTAL HYGIENE IN INDUSTRY

T. T. READ, *Chairman* F. M. BARNES H. M. WOLFLIN
(To coöperate with National Committee for Mental Hygiene)

SUB-COMMITTEE ON PREVENTION OF ILLNESS

H. I. YOUNG, *Chairman* A. P. LANZA L. A. SHOUDY
(To coöperate with American Public Health Association, etc.)

SUB-COMMITTEE ON SAFETY

B. F. TILLSON, *Chairman* H. G. DAVIS J. W. PAUL
(To coöperate with National Safety Council)

SUB-COMMITTEE ON SOCIAL SURVEYS

C. W. GOODALE, *Chairman* PHILIP R. BRADLEY FRANCIS P. SINN
(To coöperate with Russell Sage Foundation)

COMMITTEE ON ARRANGEMENTS, NEW YORK (119TH) MEETING, 1919

ALLEN H. ROGERS, *Chairman* W. S. DICKSON, *Secretary*

J. E. JOHNSON, JR.
R. C. PARMELEE
F. T. RUBIDGE
FOREST RUTHERFORD
P. G. SPILSBURY

OFFICERS AND DIRECTORS

For the year ending February, 1919

PRESIDENT

SIDNEY J. JENNINGS, ... New York, N. Y.

PAST PRESIDENTS

L. D. RICKETTS, ... New York, N. Y.
PHILIP N. MOORE, ... St. Louis, Mo.

FIRST VICE-PRESIDENT

C. W. GOODALE, ... Butte, Mont.

TREASURER

GEORGE C. STONE, ... New York, N. Y.

SECRETARY EMERITUS

ROSSITER W. RAYMOND, ... New York, N. Y.

SECRETARY

BRADLEY STOUGHTON, ... New York, N. Y.

VICE-PRESIDENTS

KARL EILERS,[1]	District 0	New York, N. Y.
JAMES MacNAUGHTON,[1]	District 4	Calumet, Mich.
CHARLES W. GOODALE,[2]	District 5	Butte, Mont.
MARK L. REQUA,[2]	District 6	San Francisco, Cal.
HENRY S. DRINKER,[3]	District 2	So. Bethlehem, Pa.
ROBERT M. RAYMOND,[3]	District 0	New York, N. Y.

DIRECTORS

GEORGE D. BARRON,[1]	District 0	New York, N. Y.
EDWIN LUDLOW,[1]	District 2	Lansford, Pa.
CHARLES F. RAND,[1]	District 0	New York, N. Y.
THOMAS B. STEARNS,[1]	District 7	Denver, Colo.
B. B. THAYER,[1]	District 0	New York, N. Y.
J. E. JOHNSON, JR.,[2]	District 0	New York, N. Y.
ALLEN H. ROGERS,[2]	District 1	Boston, Mass.
HOWARD N. EAVENSON,[2]	District 9	Gary, W. Va.
J. V. N. DORR,[2]	District 0	New York, N. Y.
WILLET G. MILLER,[2]	District 11	Toronto, Canada.
FREDERICK G. COTTRELL,[3]	District 6	San Francisco, Cal.
HENNEN JENNINGS,[3]	District 9	Washington, D. C.
GEORGE C. STONE,[3]	District 0	New York, N. Y.
SAMUEL A. TAYLOR,[3]	District 2	Pittsburgh, Pa.
ARTHUR THACHER,[3]	District 3	St. Louis, Mo.

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921.

The Relation of Sulphur to the Overpoling of Copper

Discussion of the paper of S. Skowronski, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, p. 651.

F. Johnson,* Birmingham, England (written discussion†).—Mr. Skowronski's first melting experiments tend to show that ingots with a "level set" may be obtained without oxygen. Now it is characteristic of all metals which occupy a smaller volume when solid than they do when molten to "pipe." In vertical-cast ingots, this pipe resembles a horn-shaped cavity, with the wide mouth uppermost. In horizontal-cast ingots, the pipe is a longitudinal furrow along the center-line of the ingot surface.

If copper be successfully deoxidized *and degasified*, this furrow will inevitably be produced. In the author's oxygen-free ingots, it is clear that gases were occluded and these gases effectively opposed the formation of a pipe or furrow by shrinkage (fluid contraction). It is not a special property of any particular gas which produces this effect. Hence it is not surprising that the author has succeeded in producing level and overpoled ingots through the agency of sulphur dioxide gas. That he has counteracted the overpoling influence of sulphur by means of oxygen is somewhat difficult to explain, since the well known reaction between cuprous sulphide and cuprous oxide should result in the production of sulphur dioxide gas. Why the presence of excess cuprous oxide should neutralize the overpoling influence of this gas without eliminating sulphur is not at all clear. It is to be regretted that the oxygen was not determined in the bars given in Tables 3 and 4.

It is by no means established that sulphur is responsible for the overpoling of ingots given in Table 4, since carbon was used for overpoling. If, however, the same kind of poling treatment was given as that applied in the case of ingots in Table 1, the responsibility of sulphur assumes more definite shape.

The author rightly points out that Mr. Johnson's theory of the equilibrium between gases and cuprous oxide does not explain why a simple addition of cuprous oxide does not correct an overpoled charge. Such a charge must be re-worked to "set" copper. This re-working (rabbling) undoubtedly forcibly removes the excess gases, which are not removable by cuprous oxide.

The writer suggests that the gases concerned in the production of "tough-pitch" copper are of two kinds, soluble and insoluble. The

* Head of Metallurgy Department, Municipal Technical School.

† Received Sept. 12, 1918.

soluble gases, such as hydrogen and possibly carbon monoxide, may be capable of being retained in solid solution and therefore would, if wholly in this condition, play no part in the formation of "set."

In the absence of other gases, and of cuprous oxide, such copper should set with a depression and give characteristically underpoled ingots. The introduction of cuprous oxide is followed by a reaction, for example:

$$2H_2 + O_2 = 2H_2O$$
$$2CO + O_2 = 2CO_2$$

Thus insoluble gases are formed which cannot be retained in solid solution and which, in endeavoring to escape before solidification is complete, will oppose themselves to the natural shrinkage of the metal and result in the production of ingots with level surfaces (tough-pitch) or of overpoled ingots, if in excess. The action of overpoling will thus be the production of more soluble gases which react with cuprous oxide and produce an accumulation or excess of insoluble gases. This excess would cause spewing.

The writer has no experimental evidence to offer in support of this theory, but the inability of cuprous oxide to neutralize the overpoling action of insoluble gases is thus explained. Their removal must be effected mechanically.

The writer has found, in his experience, that it is possible to produce ingots of electrolytic copper which are so overpoled as to spew even on an experimental scale. The copper used was cathode copper of high electrical conductivity (over 101 per cent.); sulphur was not determined.

S. M. Hopkins, metallurgist at the Birmingham Battery Co., and a copper refiner of many years' experience, confirms this.

Electrolytic Zinc

Discussion of the paper of C. A. Hansen, presented at the Colorado meeting, September, 1918, and printed in Bulletin No. 135, March, 1918, p. 615.

C. A. Hansen (communicated appendix*).—Since the above paper was written, tests have been conducted with a view to securing a sounder basis for discussing the effects of temperature on the behavior of the zinc cell. The following data, while making no pretense to great accuracy, are still reasonably close.

Cells were operated with the same feed solutions, but at varying temperatures, the latter being controlled by means of immersed steam coils. Current efficiencies obtained indicate that the corrosion rate

* Received Oct. 4, 1918.

doubles with each rise of 21.7° C. in electrolyte temperature. No great error is therefore introduced in the original paper as a result of the temperature coefficient there assumed.

Strangely enough, parallel tests conducted by merely suspending cathode sheets in solutions maintained at different temperatures (the sheets not functioning as cathodes at all) indicated no definite temperature coefficient of corrosion. It appeared in these latter tests that adhering hydrogen interfered with the free access of the acid solutions to the zinc surfaces.

Tests were also conducted with an electrically heated evaporating pan (immersed heaters) in which some 2 sq. ft. of electrolyte surface was freely exposed to the cell room atmosphere. The data obtained, corrected so as to cover merely losses of energy from the actual solution surface, indicate surface losses as follows (room temperature 20 to 25° C.):

Solution Temp., Deg. C.	Watts Loss per sq. ft.
30	25
35	45
40	70
45	115
50	155
60	270
70	400
80	540

These data are very closely checked by an independent set of tests conducted on commercial cells.

In the temperature range 40 to 45° C., evaporation of solution from electrolyte surface accounted for 87 per cent. of the energy dissipated at the surface, this figure being in excellent agreement with the 90 per cent. figure quoted from Mr. Antisell.

I think it probable that the energy lost from the cell solution surfaces is mainly accounted for by evaporation at all temperatures, since the relation between vapor pressure of the electrolyte and the energy losses determined is too simple to be mere coincidence.

Discussion

C. A. Hansen.—Mr. Yardley[1] seems to lay stress upon adapting the electrolytic plant to standard types of electrical apparatus. Personally, while I believe in keeping standard voltages, etc., in mind in laying out an electrolytic plant, I think that the electrical apparatus is a decidedly minor item in the plant as a whole.

A plant should be designed to do what it must do, and, in general, the electrical apparatus should be selected to fit in with the rest of the design. Ordinarily, the substation equipment for an electrolytic zinc

[1] *Bulletin* No. 142 (October, 1918) 1528.

or copper plant will account for about 10 per cent. of the total plant cost, and it does not seem fair to let considerations of standard voltages, etc., in any way prejudice the design of the other 90 per cent.

Mr. Yardley's point that no great voltage range need be required of the direct-current generating apparatus is well taken. When working with zinc sulfate, no current flows through the cells until a voltage greater than 2.7 per cell is applied; the average voltage of the commercial zinc cell operating at full load is around 3.5. Obviously then, the whole range from zero load to full load may be taken care of by a voltage range between 2.7 and 3.5, or, say, by a 250 plus or minus 32 volts.

Such requirements can be very conveniently met with rotary converters and synchronous booster sets. With power at about $25 per horsepower-year, there appears to be little hope of reducing the power cost per ton of zinc below $14 for the electrolytic zinc plant.

The difference of 4 per cent. in efficiency in favor of rotary converters, as compared with motor-generators, is quite an important item (say $25,000 per year for a plant averaging 100 tons zinc output per day). However, if a rotary converter is operated from a line of tricky voltage characteristics, or from a line subject to frequent lightning disturbances, this apparent saving is often wiped out in plant interruptions. The motor-generator equipment will unquestionably be less subject to these objectionable line disturbances.

It should also be remembered that the synchronous booster must provide the required voltage variation for the converter equipment, and that the booster set is a motor-generator with all of its efficiency limitations. Maximum efficiency for the synchronous converter-booster set is then to be arrived at by requiring minimum voltage range.

Perhaps a specific instance may be cited for illustrative purposes. One of the large electrolytic plants in the country specified a direct-current voltage range from 75 to 175, with a nominal load at the higher voltage approximating 4000 kw. To cover this requirement with a converter-booster set would mean a converter voltage of 125, and a booster range of 50. The required voltage range made motor-generator sets appear more favorable and they were installed. It actually developed that until 125 volts were impressed no current flowed through the cells; hence a converter supplying 150 volts, with a 25-volt booster, would have given more regulation than the plant required. In this particular instance, power costs approximately $80 per horsepower-year, and the power conditions are very favorable for a converter installation. Had the converter equipment with small voltage range been installed, the power saving would approximate $14,000 per year. However, the added power cost approximates only 0.035 c. per pound of product made, not an appreciable fraction of the production cost.

SIDNEY J. JENNINGS, New York, N. Y.—Mr. Hansen emphasizes

the need of a perfectly pure zinc sulfate electrolyte for a satisfactory operation. The owners of the Tainton process assert that they are commercially operating a plant in England where, by employing high current densities, they are able to work upon an impure electrolyte and obtain a satisfactory zinc.

C. A. Hansen.—Until a year ago, I think I was fairly familiar with all of the work being done both in this country and abroad on electrolytic zinc, and I am absolutely certain that there is no question as to the fundamental necessity for pure electrolyte. If I remember correctly, the Tainton process is characterized merely by its use of high current densities and high acidities. The behavior of the zinc cell under these conditions has been covered in the paper presented. The high current density renders one relatively independent of corrosion rates provided solution temperatures can be kept low, but the high current density militates against low solution temperatures.

The Metallography of Tungsten

Discussion of the paper of Zay Jeffries, presented at the Colorado and Milwaukee meetings, September and October, 1918, and printed in *Bulletin* No. 138, June, 1918, pp. 1037 to 1092.

Paul D. Merica,* Washington, D. C. (written discussion†).—This paper is a discussion of some of the results of a recent investigation[1] of Prof. Zay Jeffries, and of his interpretation and generalizations from these results. This work I have followed with great interest and with appreciation of its value in clarifying our views on the nature of deformation in metals and its relation to structure. It is only by such close study of the relation of structure to mechanical properties that we shall ever be able to describe the latter in terms of their ultimate elements, and thus explain what are still mysteries in the mechanical behavior of metals; experiment and thought along these lines are in my opinion of the utmost value. If I, therefore, here record some of the difficulties I have experienced in understanding some of the generalizations of Prof. Jeffries, it is only in order that perhaps from the discussion may emerge a clearer and more consistent statement of hypothesis or theory in explanation of the facts discovered by him.

* Metallurgist, U. S. Bureau of Standards.

† Received Sept. 28, 1918.

[1] Article 1: The Metallography of Tungsten. *Bulletin* No. 138 (June, 1918) 1037.

Article 2: The Amorphous Metal Hypothesis and Equi-cohesive Temperatures *Jnl.* Am. Inst. Met. (1917) **11**, 300.

Before considering the author's propositions in detail, I wish to group a few concepts and assumptions with which I here have to deal.

(1) The amorphous-metal hypothesis postulates crystalline and amorphous metal; the former, the substance of the grain in crystal, the latter existing (*a*) as a cement between grains, (*b*) in metal deformed below the re-crystallizing temperature range, at the planes along which slip has occurred.

(2) The amorphous metal at the grain boundaries and that formed at a slip plane may or may not be identical in properties, but I shall make that as an initial assumption; this assumption is tacitly made by the author.

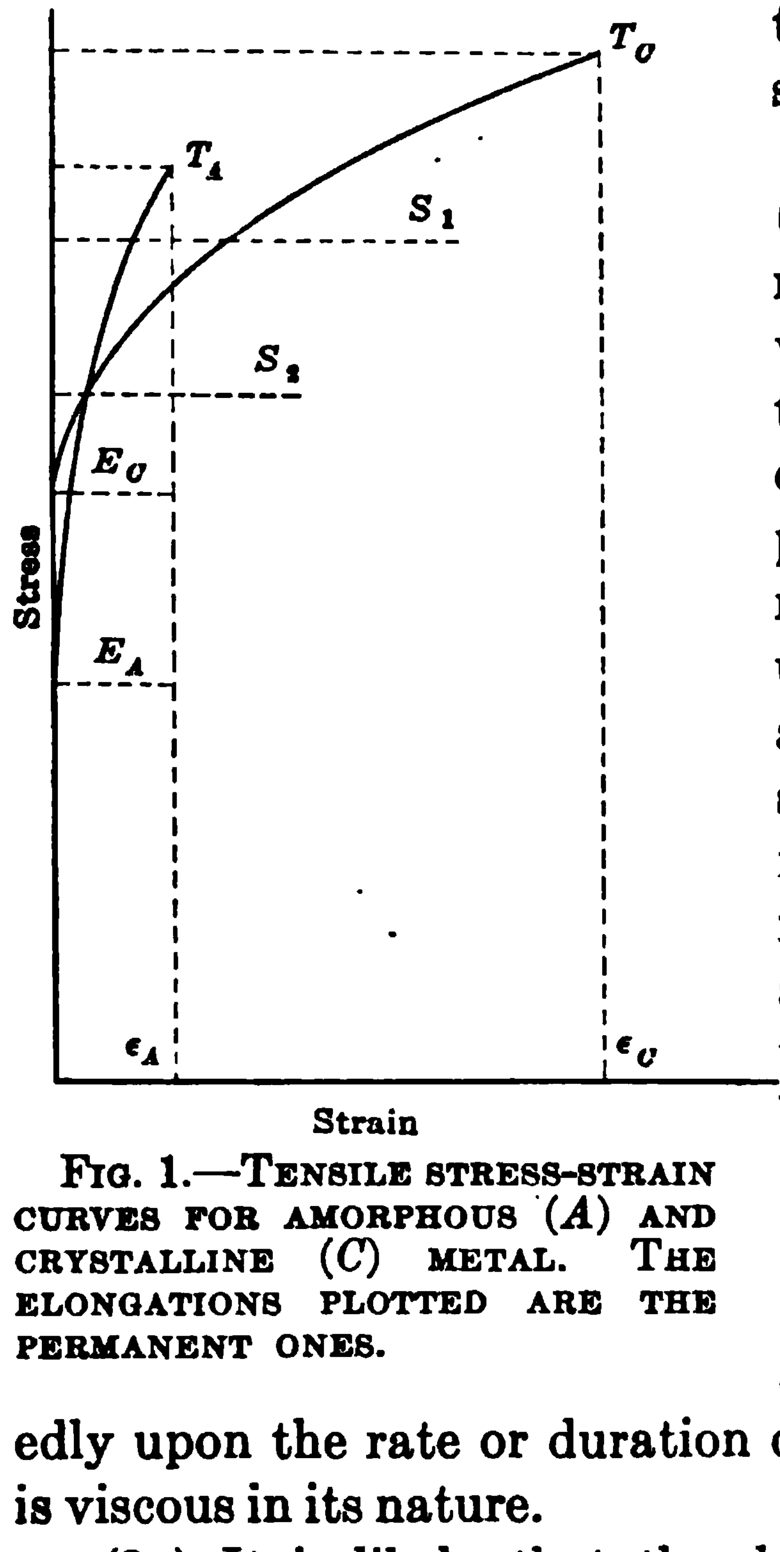


FIG. 1.—TENSILE STRESS-STRAIN CURVES FOR AMORPHOUS (*A*) AND CRYSTALLINE (*C*) METAL. THE ELONGATIONS PLOTTED ARE THE PERMANENT ONES.

(3) Each variety of metal, crystalline (*C*) and amorphous (*A*), has its own mechanical characteristics, with three of which I shall be concerned: the ultimate tensile strength, the elastic limit, and the elongation at rupture. Neglecting the phenomenon of "necking-down" at rupture, which is a consequence of non-uniformity either of stress or of strength along the axis of a bar in tension, the stress-strain curves of *C* and of *A* metal may be assumed to have the general form shown in Fig. 1. The *C* metal has a definite elastic limit, and its properties are directional. The *A* metal probably has no definite elastic limit, but we may assume a value E_A at which the permanent deformation exceeds a certain arbitrary value; the properties of *A* are not directional, but depend undoubtedly upon the rate or duration of application of stress; *i.e.*, the *A* metal is viscous in its nature.

(3*a*) It is likely that the elastic limit of a grain can be increased in any direction, as Tammonn has shown, by the gradual exhaustion of the most accessible slip planes, but the ultimate tensile strength of the crystalline metal of a grain in any direction probably is a function only of temperature. The curves of E_C shown in Fig. 2 are to be considered as those of the undeformed metal; the values may be raised possibly up to those of T_C.

(4) The effect of temperature on the shape of these curves is to diminish T_A, T_C, E_A, and E_C, and to increase ϵ_A and ϵ_C.

(5) The tensile ductility is measured by the amount of permanent set per unit length occurring between T and E; it is undoubtedly a func-

tion of the rate of loading between these two values of stress. Exhaustion of ductility occurs, as Prof. Jeffries points out, not because the metal cannot be further plastically deformed, but because the tensile load necessary to produce the deformation will first rupture the bar. According to Prof. Jeffries, the variations in the values of E_A and E_C, respectively, with temperature are such that for every metal (and alloy) there is a temperature (EC_E) below the melting point, such that

$$\begin{array}{rl} \text{above } EC_E & E_C > E_A \\ \text{at } EC_E & E_C = E_A \\ \text{below } EC_E & E_C < E_A \end{array}$$

This is the equi-cohesive temperature; see Fig. 2, in which E_A and E_C are shown as functions of temperature.

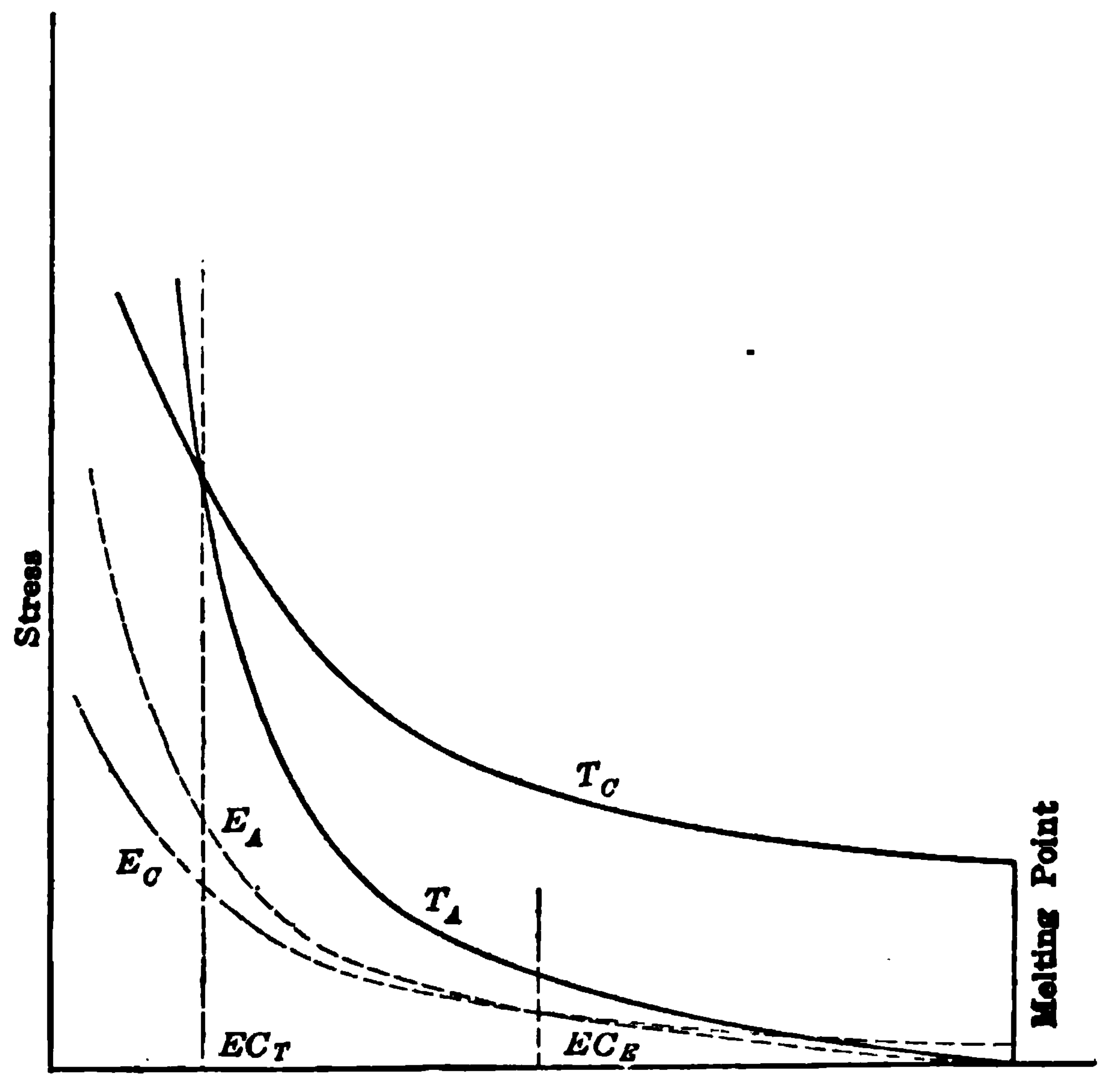


FIG. 2.—EQUI-COHESIVE TEMPERATURES AND THE EFFECT OF TEMPERATURE ON E (UNDEFORMED) AND T.

(6) I should like to call attention to another equi-cohesive temperature, namely, that at which the tensile strength of A and C metal are equal; such a temperature has been predicted by Rosenhain.[2] This is shown in Fig. 2; EC_E, the equi-cohesive temperature for elastic limits, and EC_T, that for tensile strength, are not necessarily equal.

(7) When a metal ruptures in tension, the path of rupture is never straight; it passes sometimes through the grains (intracrystalline) and

[2] Walter Rosenhain: "An Introduction to the Study of Physical Metallurgy." New York, 1914. D. Van Nostrand Co.

sometimes along the grain boundaries (intercrystalline). The rupture along those portions not perpendicular to the direction of the net tension occurs, very probably, partly as a result of shearing stresses. The load necessary to cause fracture is probably proportional to the area of the path of rupture.

(8) In any case, I wish to make two assumptions regarding rupture:

(*a*) That the total force to cause rupture is proportional directly to area of its path, counting sheared areas as equal in effect to those separated in direct tension.

(*b*) That the path of rupture across a grain, which usually appears to be straight, but which may involve serrations such as to increase its apparent length, is actually no longer than the path around the boundary of a spherical grain of which the apparent path is a diametral plane.

(9) In case the grain is elongated perpendicular to the general direction of stress and path of rupture, there are three potential paths of rupture:

(*a*) Across grain, through C metal.
(*b*) Across grain, through A metal (at a slip plane).
(*c*) Around grain, through A metal.

Rupture will occur along that path for which the product of area and unit strength is least.

I wish now to discuss on this basis some of the propositions suggested by Prof. Jeffries.

(*A*) On page 1067 (Article 1), the author explains the absence of ductility at ordinary temperatures in tungsten consisting of equi-axed grains as existing "because the brittle amorphous phase at the grain boundaries permits rupture before a load sufficient to deform the malleable crystalline phase can be applied;" *i.e.*, because $T_A < E_C$ at ordinary temperatures. In his other paper (Article 2) he has found that EC_E for equi-axed tungsten was approximately 1350° C. Therefore $E_A > E_C$ below 1350° C. But, since $T_A > E_A$, therefore $T_A > E_C$ below 1350° C., a conclusion which is the exact opposite of the one assumption used above.

This contradiction may be explained, possibly, by the fact that the equi-cohesive temperatures which Prof. Jeffries determined[3] are not the equi-cohesive temperatures as he defines them on p. 311 of the same article. Reference to Fig. 1 will illustrate this; the two curves are the stress-strain curves of A and of C metal at a temperature (t), above the equi-cohesive temperature EC_E, as defined on p. 311 by the author; *i.e.*, such that $E_C < E_A$ and $t < EC_E$. Yet at a stress, S_1, the permanent set of the crystalline metal is, however, greater than that of the amorphous metal; it will be observed that it is the temperature at which, for a given stress, the permanent deformations of A and C metal are equal,

[3] *Jnl.* Am. Inst. Met. (1917) **11**, 312.

which the author determines and calls equi-cohesive temperature (p. 312).

To explain lack of ductility of equi-axed tungsten along the general line of the author's explanation, we might then assume that at ordinary temperatures we are above EC_B, not below it.

(*B*) On p. 1071 (Article 1), the author says, "The underlying reason for the loss of ductility by working a metal at a certain temperature below its annealing temperature" (*EC* probably) "and the regaining of ductility by cooling to some lower temperature, is that the amorphous phase of any metal will increase in cohesion on cooling, at a faster rate than the crystalline phase." I believe that this is not quite accurately stated; the necessary conditions to produce this effect are not so simple. They appear to me to be as follows:

(1) Since the strength of the *A* metal is to determine the ductility, fracture must take place through it; *i.e.*,

$$\phi_A T_A < \phi_C T_C$$

where ϕ_A and ϕ_C are the areas of the potential paths of rupture through *A* and *C* metal, respectively.

(2) But the fact is established that fracture takes place across a deformed grain; *i.e.*, through *A* metal, at slip planes either in tungsten (see p. 1067) or in other metals below *EC*.

(3) Therefore $\phi_A = \phi_C$ (approx.) and $T_A < T_C$.

(4) The condition for the exhaustion of ductility is not that the "cohesion" of *A* and of *C* become equal, but that I_A is not equal to nor greater than E_C.

(5) In order that the ductility of deformed metal may reappear upon lowering the temperature, the quantity $(T_A - E_C)$ must increase with this lowering.

These conditions are represented in Fig. 2, and are quite possible ones; in fact the author's hypothesis could quite well fix the case of tungsten. But it is to be observed that condition (3) would require that in any metal within the temperature range within which ductility after deformation was restored upon lowering the temperature, fracture should occur within the same temperature range in an equi-axed grain at the grain boundaries: *i.e.*, this range is above EC_T.

But this is not true of gold, silver and copper, in which this identical phenomenon occurs. In these metals, at those temperatures, $T_A > T_C$, and the amorphous metal does not determine strength nor ductility.

(*C*) There is, however, a further contradiction in the author's views to which I wish to call attention. On p. 1067 (Article 1) he says that fibrous tungsten "is ductile because the grain distortion by working arranges the grain boundaries in such a manner that the resistance to rupture along them is so great that rupture is forced to take place through

the deformed grains themselves." In other words, equi-axed tungsten is brittle because $\phi_A T_A < \phi_C E_C$, where $\phi_A = \phi_C$ approx. When the grains are elongated, ϕ_A becomes large enough that $\phi_A T_A > \phi_C E_C$, and the fracture takes place across the grain. Now, on the basis of assumption (2) above, this fracture cannot be through A metal; for we should have, in that case, $\phi_{A_1} T_A$ (of fibrous grains) $> \phi_{A_2} T_A$ (of equi-axed grain). But $\phi_{A_1} = \phi_{A_2}$ (approx.) if the path of rupture is across grain; therefore $T_A > T_A$, an obvious absurdity. Therefore, axial fracture in fibrous tungsten must be through the crystalline metal; *i.e.*, $T_A > T_C$. But this contradicts the assumption (1) under (B), necessary to explain the regaining of ductility of deformed tungsten upon lowering the temperature.

These are some of the difficulties I have experienced in reconciling the various views of Prof. Jeffries, which lead me to wonder whether we must not examine more closely into the tacit assumptions which are made in developing such hypotheses, and also into the exact nature of deformation, before we may attempt to generalize to any too great extent. Such questions as the following must receive more thorough attention:

(1) Is amorphous metal the same in properties whether at slip planes or at grain boundaries?

(2) What is the actual shape and area of a fracture across a grain; in other words how serrated is this path?

(3) Does fracture across a grain occur within crystalline or within amorphous metal?

(4) What is the nature of the resistance to plastic deformation within a grain? This resistance would seem to be in reality a very complex function.

I believe the recent experimental results of Prof. Jeffries, as well as those of other investigators whom he has quoted, can contribute much to the elucidation of these specific questions.

J. C. W. Humfrey,* Sheffield, England (written discussion†).—Prof. Jeffries' paper gives a very complete description of the metallurgy of tungsten, the details of which afford a striking illustration of the application of scientific principles in overcoming practical difficulties of manufacture. In addition to this practical side, it deals with two phenomena of great theoretical importance and of general metallographic interest, viz.:

(*a*) Grain growth in metals.

(*b*) The significance of intercrystalline cohesion.

It is chiefly with the second of these two subjects that I propose to deal in the following remarks.

---

* Admiralty Inspection Officer.

† Received Sept. 28, 1918.

On page 1066 the author states that he accepts the amorphous boundary theory, viz., that the crystals in a mass of metal are joined to one another by a cement of the same metal, in the amorphous or non-crystalline state. Agreeing, as I also do, with the validity of this theory, I am unable to accept certain of the interpretations he puts upon it, or to follow his arguments as to the manner in which his experimental data may be taken as a confirmation of its truth.

The author appears to consider the amorphous cement as occupying a volume in the mass comparable with that of the crystals, and deals with the mechanical properties of the mass as if the two phases were distinct from one another and possessed little or no mutual adhesion. His comparison of the structure of tungsten with a mass of iron crystals embedded in glass is not, I think, a very happy one, nor is it indicated either by the mechanical properties of metals in general nor of this one in particular.

In a paper (which he quotes in the bibliography, No. 33) I put forward a theory based on the view that the amorphous cement owes its origin to the impossibility of two differently oriented crystals fitting exactly into one another, and the consequent existence of a certain range of atoms between them which, since they are being constrained by each crystal in a different manner, are forced to take up some irregular grouping between the two. According to this theory, there is no sharp line of demarcation between crystalline and amorphous, and the one must merge gradually into the other. The whole thickness of the disturbed layer is of molecular rather than of microscopic dimensions, and, while the amorphous envelopes are incapable of plastic deformation, yet they are capable, in consequence of their extreme thinness, of considerable distortion relative to the crystals they surround by means of elastic bending.

In all metals which are at temperatures considerably below that of their melting points, the amorphous phase is, as is illustrated in the author's Plate 3 (page 1072), of such an extremely viscous nature as to be incapable of plastic deformation, but to possess very considerable tenacity or cohesion. If, therefore, we accept the author's theory that the intercrystalline fracture of his tungsten is due to the brittleness of the amorphous cement, then such a form of fracture should be the rule rather than the exception in other metals. The paper refers to one other case only, viz., iron at the temperature of liquid air; but the author does not state whether he has obtained direct experimental confirmation of the fact, nor does he quote any authority to support it. In Hadfield's paper (No. 38 in the bibliography), while it was shown that iron was brittle at this low temperature, yet I can find no reference as to whether the brittle fractures followed the crystal boundaries or the crystal cleavages. Since, however, the brittleness was accompanied by a high tenacity, I should prefer to assume the latter rather than the former.

When a metal tends to fracture around rather than through the crystals, it must surely be an indication that the *tenacity* of the cement is less than that of the crystals, and, provided the thickness of the cement is sufficiently small, its lack of plastic ductility does enter into the matter. All metals in their normal state tend to fracture around the crystals when at temperatures just below those at which they freeze (bibliography, No. 31). In this range, the amorphous cement is more capable of plastic deformation than the crystalline, but possesses considerably less tenacity. Below the temperatures which the author terms those of "equi-cohesion," the fractures change to cleavage. If, at still lower temperatures, the fractures again reverted to intercrystalline, then it would have to be assumed that the tenacity of the amorphous phase had begun to decrease with temperature, or at least to increase at a lower rate than the crystalline, and that the two curves in the author's Plate 3 again crossed one another. Such a reversion is most unlikely, and opposed to all our experimental knowledge.

We do, however, know of cases in which certain metals, which normally break through the crystals, may be so altered in character as to tend to break around them. Typical examples of this are:

(*a*) Gold containing small percentages of bismuth. It has been shown that the weakness is due to the presence of a fragile gold-bismuth eutectic.[1]

(*b*) Pure iron which has been annealed at certain temperatures and in certain atmospheres, and slowly cooled through a certain range. In this case there is evidence to indicate that the weakness is due to the formation of an iron-oxide eutectoid.[2]

(*c*) Nickel-chrome and certain other alloy steels, when hardened by quenching, annealed below the critical range, and then allowed slowly to cool through a range of temperature in the neighborhood of 500° C. In this case there is as yet no experimental evidence to indicate what is the important factor; but the general nature of the phenomena again points to the formation of a eutectoid.[3]

In the above examples it would appear that, contrary to the normal amorphous cement being responsible for the intercrystalline weakness, it is rather the fact that the presence of some foreign material between the crystals has interfered with its proper formation. It is suggested that it is to some similar interfering agent that the weakness found in tungsten, as made by the process now employed, should more properly be ascribed.

---

[1] J. O. Arnold and J. Jefferson: Influence of Small Quantities of Impurities on Gold and Copper. *Engineering* (Feb. 7, 1896) **61**, 176–179.

[2] J. C. W. Humfrey: The Intercrystalline Fracture of Iron and Steel. *Carnegie Scholarship Memoirs*, Iron and Steel Inst. (1912) **4**, 80–105.

[3] H. P. Philpott: Some Experiments on Notched Bars. March, 1918, meeting, Inst. of Automobile Engrs. Will probably be published in *Proceedings* (1918–19) **12**.

Future researches will, I think, find a method of preparing metallic tungsten which shall be free from such weakness and have mechanical properties in line with those of other metals. The preparation of such material would be of great practical importance and would well repay the labor of a lengthy investigation.

It is fairly obvious that severe deformation by such processes as wire drawing or swaging will tend to strengthen a metal which originally lacks intercrystalline cohesion, since it must result in a certain amount of dovetailing of the crystals into one another. If, however, it is assumed that the original brittleness was due to the presence of the amorphous cement, it would appear that the contrary would be the case, since many additional planes of weakness would be produced by the formation of amorphous matter in the slip planes.

Cold working of a metal must necessarily, I think, be accompanied by the formation of internal stresses, partly due to unequal external loading, partly to the difference in resistance offered by the crystals and the amorphous matter surrounding them and formed during deformation, and partly to varying plasticities of different crystals, owing to the way they are oriented to the main axes of strain. When a certain degree of deformation has been given, the internal stresses at certain places may rise to that of the maximum tenacity of the metal. Further deformation at the same temperature must then immediately lead to internal rupture; this is the state of maximum tenacity which can be produced in the metal by cold work. If, however, the temperature of the metal be reduced, the tenacities of both the crystalline and the amorphous phases are increased, and further deformation may now be applied before the internal stresses again become equal to the tenacities, *i.e.*, the metal has acquired additional ductility. This explanation is applicable to all metals, including tungsten, and is independent of the relative tenacities of the crystalline and amorphous phases, provided only that both increase with falling temperature.

The Condensation of Zinc from Its Vapor

Discussion of the paper of C. H. FULTON, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1375.

E. E. THUM,* Salt Lake City, Utah (Written discussion†).—Dr. Fulton's paper sheds a great deal of light upon questions which have perplexed many who have studied the metallurgy of zinc, and have fruitlessly brought forth several hypotheses and reams of discussion. It would be a bright day if others would follow Dr. Fulton's example, for, as a

---

* Western Editor, *Chemical and Metallurgical Engineering.*

† Received Sept. 28, 1918.

prominent metallurgist recently said, the zinc smelters' adherence to old practices is not so much for the reason that no research has been undertaken, for a great deal has been, but rather because the results have not been published.

On page 1383, Dr. Fulton states that carbon dioxide in excess of 1 per cent. is not found in the gases distilled above the carbon-reduction temperature; yet in Table 1, page 1380, we find in experiment 8b, at perhaps 1500° C., that CO_2 is given as 2.5 per cent. Other results, notably experiment 12c at 1500° C., show higher percentages of carbon dioxide. Dr. Fulton refers to this 1 per cent. carbon dioxide maximum several times later in the paper, apparently at some discrepancy with his experimental results.

On page 1393, Dr. Fulton states that the reaction $2CO \leftrightarrows CO_2 + C$ proceeds from left to right much more rapidly at 500° than at 700°. That is true, of course, since CO_2 is the usual form at low temperature; yet on page 1383, in discussing the effect of carbon dioxide on the condensation, he states that at the end of the distillation the proportion of dioxide increases, particularly when the temperature is high (above 1400°), the monoxide suffering decomposition into carbon dioxide and carbon. That is a point, it seems to me, that Dr. Fulton would do well to elucidate at some length. The reaction he indicates is, of course, a reversible reaction, and the equilibrium concentration-temperature diagram has been well worked out, showing that carbon dioxide is stable at low temperature, but reverts to carbon monoxide at higher temperatures. Now, if that reaction again reverses at 1000° C. and higher, it would be a rather peculiar reaction and of a type which is not at all common in physical chemistry, since highest-temperature decomposition of carbon monoxide might produce carbon and oxygen rather than carbon dioxide and carbon.

Dr. Fulton says that his experiments were conducted under rigorous conditions to determine the gas from the distillation chamber. He states that "For this purpose, porcelain and quartz tubes were used, having been demonstrated to be tight and refractory enough for the temperatures employed." These at times reached 1500° C. One who is familiar with the rapid deterioration of platinum thermocouples in reducing atmospheres at 1500° C., even when protected by the best fused-quartz tubes, would doubtless be glad to be reassured as to this point. Doubtless Dr. Fulton will give us detailed information as to the tests he made to establish the imperviousness of his tubing, especially since Alleman and Darlington, of Swarthmore College, were forced to great extremes before they were able to construct a furnace that was gas tight at such high temperatures.[1] These two scientists ascribe

[illegible] Alleman and C. J. Darlington: Occluded Gases in Ferrous Alloys. *Jnl.* [illegible] (Feb., 1918) 185, 161, 333, 461.

much of the variation in published results on occluded gases in metals to insufficient precautions to insure against leakage of gases through the walls of the apparatus in use.

The Manufacture of Ferro-alloys in the Electric Furnace

Discussion of the paper of ROBERT M. KEENEY, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, pp. 1321 to 1373.

E. S. BARDWELL,* Great Falls, Mont. (written discussion†).—There are several points in connection with the manufacture of ferromanganese in the electric furnace which it seems to me might prove of interest in this connection. Recent observation of a number of electric furnaces varying considerably in size and transformer capacity, and all working under the same conditions, shows the small furnaces to be much more efficient in operation than the large furnaces.

The furnaces examined were all of the same type. The crucibles consisted of tanks varying in size from 7½ by 15 ft. by 4½ ft. deep, to 12 by 20 ft. by 9 ft. deep, with linings formed of carbon electrode butts. The smaller furnaces had transformer capacity rated at 1500 k.v.a.; the largest furnace had a transformer rated at 3000 k.v.a. All of the furnaces were operated on three-phase, 60-cycle current, the three electrodes being in a straight line. The voltages varied from 65 volts in the smaller to 100 volts in the larger furnaces. The charges consisted of manganese ore, coal, iron turnings, and limestone in proper proportions.

The small furnaces, operating at low voltage, were making good recoveries. The slag loss was low and the volatilization loss almost nil. The larger furnaces, operating at higher voltages, showed increased loss of manganese in the slag and greatly increased volatilization loss when working on the same charges as the smaller furnaces, or on charges similarly calculated.

The exact reasons for this state of affairs are difficult to state; a number of factors probably contribute to the results obtained in the large furnaces. First as to the effect of the higher voltage on manganese content of the slags. Increasing the voltage of the furnaces apparently tends to promote irregular working. The current takes the path of least resistance; this means superheating in certain areas in the crucible and insufficiently high temperatures in adjoining areas. The partially reduced manganese in the cooler areas passes into the slag and escapes further reduction.

---

* Metallurgist, Anaconda Copper Mining Co.

† Received Sept. 20, 1918.

As to the effect of the higher voltages on volatilization losses, it is clear that the result of the excessively high local temperatures will be to augment volatilization. Furnaces operating at the higher voltages are also subject to the formation of accretions consisting of carbide and graphite, which tend to form with an excess of carbon. The formation of carbide robs the charge of a portion of its lime, rendering the slag composition very different from that calculated and desired. The electrodes are forced up, and volatilization is still further increased. The presence of carbide and graphite in the furnaces working at the higher voltages points to the existence of higher temperatures in these furnaces than in those operating at lower temperatures. The small furnaces rarely show signs of accretions, although both carbide and graphite are formed in them to a limited extent.

The advantages to be gained from having a large unit are obvious, although there is much to be said in favor of a number of smaller units. Assuming for the moment that a large furnace is desired, let us consider the voltage to be employed. It is evident that the large furnace possesses no advantage over the small furnace unless we can get proportional or more than proportional production from it. Output, of course, is dependent on power input. If we represent the current by I, the voltage between phases by E, and the reactance and impedance by X and Z respectively, we may write the following equations:

$$I = \frac{E}{\sqrt{3}\,Z},\ Z = \sqrt{X^2 + R^2},\ \textit{Power input} = \sqrt{3}\,EI \times (\textit{power factor}).$$

Examining the first equation, we see that the current input may be increased either by increasing E or by decreasing Z. Experiments have shown that in any given furnace the reactance, X, is a constant for all except the very lightest loads; hence any decrease in the resistance, according to the second equation, will result in a decrease in the impedance and a corresponding increase in the current and power input.

The resistance of the charge may be decreased by substituting coke for a part or for all of the coal. If this is done, and if the voltage be kept reasonably low, it should be possible to obtain increased power input and steadier operating conditions than are obtainable on the higher-voltage furnace.

R. Korten[1] gives some interesting data regarding the melting of ferromanganese in the electric furnace, particularly in the Keller furnace. He states that melting without loss of manganese by volatilization is most certain if low voltage is employed, that the arc must be short, and the hearth offer as large a surface as possible. A uniform heating over a large surface and not an intense heating over a small surface should be sought.

While conditions are not exactly the same in electric furnaces for

[1] *Stahl und Eisen* (March 14, 1912) **32**, 426.

the smelting of manganese ores, my experience has been that better results are obtained where low voltages are employed and when the power input is properly proportioned to the size of furnace employed.

As to the subject of slags, when treating Montana carbonate ore containing 36.8 per cent. Mn and 6.79 per cent. SiO_2, using coal as reducing agent and marble as flux, it has been found possible to keep the slag loss below 3 per cent. of the manganese in the ore. The average slag analysis over a period of a week was as follows: Mn, 4.26; SiO_2, 34.37; Al_2O_3, 7.93; CaO, 44.83; MgO, 4.10; BaO, 0.88 per cent.

This result is extremely good when compared with the slag losses quoted by Mr. Keeney, which vary from 12 to 25 per cent. Results like these are easy to get in small furnaces working at low voltages. I feel confident that we shall be able to duplicate them in the large furnaces after sufficient study.

The greatest problem that we have to solve is the reduction of the volatilization losses. We know that it is possible to keep this loss low in the small furnaces, and doubtless a more thorough understanding of furnace conditions will enable us to solve the problem in the case of the larger units.

H. W. GILLETT,* Washington, D. C. (written discussion†).—It would be very interesting if Mr. Keeney would give the phosphorus content of the ores and slags, as well as of the alloys, in Table 2 relating to ferromanganese, so that one could compute how much of the phosphorus in the ore went to the metal, how much to slag, and how much, if any, was lost by volatilization. In this connection it would be desirable to know also the dimensions of the furnace, especially the height of the column of charge.

Some recent experiments have indicated that, by deviating somewhat from established practice, it may be possible to eliminate a large proportion of the phosphorus from a high-phosphorus ore, and one would like to know just how much of the phosphorus is retained in the alloy in regular practice.

Has any feasible method actually been tested for the dephosphorization of a high-phosphorus ferromanganese?

On p. 1350 the conclusion is drawn that, for a ferro-uranium to contain any uranium, the carbon must be over 2.5 per cent., and to hold any large amount of uranium, the carbon must be over 3.5 per cent. However, ferro-uranium has been made[2] containing 50 to 70 per cent. U and under 2 per cent. of carbon. This was produced by using an excess of UO_2 over carbon in the charge. Keeney's conclusion that the carbon content of

* Chem., U. S. Bur of Mines.

† Received Sept. 27, 1918.

[2] H. W. Gillett and E. L. Mack: Preparation of Ferro-uranium. Bureau of Mines, *Tech. Paper* 177 (1917) 27.

the alloy cannot be controlled by the amount of carbon in the charge seems to be based on experiments with sodium uranate rather than with uranium oxide.

It will be noted in Table 32 that runs No. 97 and 98 show a recovery in steel respectively of 100 and 118 per cent. of the U in the ferro-uranium added. Runs No. 116, 117, 118, made under quite comparable conditions, show 54, 9 and 41 per cent. recovery.

No account of the method of sampling the steel, or of the method for chemical analysis of U in the steel, is given. The discrepancies referred to may possibly be explained by segregation of U, or by analytical error. Several workers had ill success with titration methods for the determination of U in steel, and in the preparation of 50-lb. billets of uranium steels of varying compositions, pronounced segregation of U has been found to be the rule rather than the exception, even when most earnest precautions were taken to prevent it. There is no question that it is difficult to cause a large proportion of the added U to be taken up by the steel, but quantitative figures on recovery may be greatly in error unless the absence of segregation of U, which might affect the sampling, is proved.

Electrostatic Precipitation

Discussion of the paper of O. H. Eschholz, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1293.

Harmon F. Fisher,* New York, N. Y.—Mr. Eschholz discusses the particular case of large precipitators installed in connection with large metallurgical operations, and receiving their high-potential energy through the conversion of alternating current to direct current by means of the mechanical rectifier. He classifies these mechanical rectifier installations, according to source of power, as follows:

System A.—Applications utilizing individual alternating-current generators, either single-phase or polyphase, installed exclusively for furnishing energy to one or more transformer-rectifier-precipitator units.

System B.—Applications having no special alternating-current generators, but utilizing the existing alternating-current industrial or lighting mains to supply the energy to one or more transformer-rectifier-precipitator units.

System C.—Applications receiving their energy from high-tension power circuits supplied directly to potential regulator-rectifier-precipitator units.

I do not intend here to enter upon a detailed technical discussion of the foregoing classes, which would really interest only the manufacturers of electrical apparatus and the electrical engineers. A brief general discussion follows:

* Division Engineer, Electrical Engineering Division, Research Corporation.

System A

Remembering that the paper under discussion is confined entirely to precipitation installations as applied to large metallurgical plants, the author is undoubtedly correct in stating that system A-1 is at present the most widely used in these applications. In this case, a generator is installed exclusively for the purpose of furnishing energy to one transformer-rectifier-precipitator set, thus permitting the greatest flexibility in operating control. By reason of this flexibility, it may be possible, in a few instances, to improve slightly on the dust recovery attainable with the simpler installations listed under system B, but as a general rule, the simpler installations can be adjusted to give any degree of clearance desired. A system utilizing individual generators does not, in our opinion, afford any greater continuity of operation than is possible with the simpler installations.

System B

It is our opinion that, of the three systems outlined in the original paper, the simplest arrangement is that of system B.

Considering precipitation as applied to all industries, undoubtedly this is and will remain the most widely applied system. It is recognized that it should not be applied to an existing power main having an energy capacity but slightly in excess of the precipitation demands, nor on a power main subject to violent fluctuations.

The author states that voltage control is obtained by means of a series resistance in the primary circuit of the transformer. There appears to be some confusion on this point; voltage control is intended to be obtained by transformer primary taps. A certain amount of voltage control can be obtained by varying the resistance in the transformer primary, but a distinctly separate and valuable property of this resistance must not be overlooked; namely, it helps to absorb the energy of the surges and oscillations which the rectifier-precipitator load impresses upon the transformer circuit.

Most modern industrial lighting and power circuits have fairly close voltage regulation; hence, in only abnormal cases will there be severe variations in the supply line which may prove detrimental to precipitator operation.

The effect of multiple-parallel transformer-rectifier-precipitator operation on voltage distortion will generally be more pronounced in system A than in system B. The effect on other industrial and lighting apparatus on the same circuit, the hazard to life and equipment caused by reflection of high voltage surges on the line, etc., are rather remote possibilities, particularly if the same auxiliary protection is installed that Mr. Eschholz mentions in the final paragraph under "Other Systems."

It may be mentioned that cases are on record where, on account of faulty operation, individual generator-transformer-rectifier sets have been replaced by synchronous motor-driven rectifier-transformer sets operating directly off the main low-potential power supply line, with greatly improved operation.

System C

This system, utilizing energy directly from a high-potential alternating-current main, has never been seriously applied, to our knowledge. Besides having no advantages and being very awkward to operate, it would have many disadvantages over the two systems already discussed.

Rectification and Electrode Vibration

As stated in the original paper, one of the sturdiest and most reliable pieces of apparatus in use to-day is the modern high-tension transformer. Under even the most severe and violent operating conditions of the past, before our present knowledge of electric circuit conditions and gas conditioning were available, this apparatus gave but very little trouble and a very nearly perfect record may be expected in the future.

For converting alternating current to direct current, the old mechanical rectifier, because of its extreme simplicity, ruggedness and ease of repair, will always appeal to the practical operating man who has become accustomed to its use.

An important property of rectifiers, because of the rapid alternate opening and closing of the high-tension circuit, is the prevention of long continuous arcing or surging in the precipitator, due to any temporary upset of the electrical equilibrium of the circuit. This feature of rectifiers is also useful in instances where the electrode spacing has become less than would correspond to the potential at which the precipitator is operating, or in the case of an accidental short-circuit. Here it prevents abnormal current rushes, and serves as a limit to the short-circuit current to which a given transformer equipment would otherwise be subjected.

The author mentions electrode vibration as being due to unbalanced electrostatic forces. These same forces have been found to exist in the most carefully conducted corona experiments, where practically perfect centering of the electrodes within the outer cylinders could be assured. The remedy is relatively simple, and consists in placing damping rods, pipes, or chains in the electrodes so as to interrupt the simple harmonic vibratory motion. Chain electrodes are less subject to this phenomenon than a single wire electrode, and in no instances has any serious trouble been experienced from this cause.

Under "Treater Problems," the author mentions certain lines of studies for the improvement of the precipitation art. It may be of interest to know that the more important of these have been carried on for an extended period, and are being conducted at the present time, and

results have been obtained which indicate the possibility of decided improvement both in the size of the precipitators and the smoothness and continuity of operation.

B. L. Sackett,* Tooele, Utah.—It may be interesting to record some actual conclusions derived from two years' operation of Cottrell precipitators at the Tooele, Utah, plant of The International Smelting Co. In emphasizing the importance of installing the best of electrical equipment in Cottrell power-houses, Mr. Eschholz states a fact which cannot be disputed, for if the electrical equipment be inefficient or insufficient, the effect is at once noted in unsatisfactory treater recoveries. However, it does not necessarily follow that the most costly installation gives the most efficient results, as the experience we have had at one of our treaters has shown.

There are two treaters at the Tooele plant which have been in operation for about two years; a four-unit, 880-pipe treater working on the gas from the Dwight-Lloyd sintering plant; and a one-unit, 220-pipe treater, working on the gas from the copper converters. In both of these treaters, pipes of 12 in. diameter and 15 ft. long are used. An additional four-unit, flue-type treater, which will treat the gas from the McDougall roasting plant, is now in course of construction.

The original electrical systems installed at the first two of the above mentioned treaters were: at the sintering-plant treater, a single-phase generator supplying power to four transformer-rectifier-treater sets operated in parallel on the low-tension side. (Mr. Eschholz's classification A-2); at the converter treater, a single-phase generator supplying power to a single transformer-rectifier-treater unit (Mr. Eschholz's classification A-1.)

Our work at Tooele during the past eight months has led us to conclude that improved treater operations can be obtained by using the electrical equipment classified by Mr. Eschholz as System B, namely, low-tension, alternating current from the smelter industrial main, supplying power to the transformer-rectifier-treater sets, rather than system A-2 or A-1.

The four-unit sintering-plant treater has been operating on system B for over two months, giving noticeably improved treater efficiency as compared with that obtained with system A-2, due to an increased power input to the treater, and a smoother wave form, as shown by oscillograms. The one-unit, converter treater will be continuously operated by system B as soon as the necessary equipment arrives. The new four-unit McDougall roaster treater will also be electrically equipped by system B.

In all of our work at these treaters, both experimental and operating, it has been shown to our entire satisfaction that the undesirable

* Blast-furnace Superintendent, International Smelting Co.

possibilities to be looked for when using system B, as given by Mr. Eschholz, really do not exist if the installation be properly made. It is actually found that system B gives smoother electrical operation, higher power-plant input, and consequently, improved treater efficiency, than did either of the other installations; and at no time has there been the slightest indication of any reflected disturbances on our main power line from either treater.

Mr. Eschholz states that the first cost of the electrical equipment for a Cottrell treater is approximately 10 per cent. of the total cost of the treater. In the case of our sintering-plant treater, the cost of the electrical equipment was 10.2 per cent. of the total cost of the treater; at the converter treater it was 15.3 per cent.

In connection with the cost of electrical equipment, we have found that the repair charges for this equipment have mounted up to a figure that is worthy of serious consideration. For example, at our sintering-plant treater, repairs have cost slightly over 40 per cent. of the first cost of the equipment in less than two years' operation.

Mr. Eschholz also states some general figures as to the value of the yearly recovery from the average Cottrell installation. The annual net profit derived from our treaters, to be applied to construction cost, is much less than that indicated by Mr. Eschholz as a minimum. In speaking of this profit, the figures given represent the gross value of the metals contained in the recovered fume, less the treater operating costs, including repairs, the cost of smelting the fume, and making proper allowance for the metallurgical losses in the smelting operation. The periods of operation represented are 22 months, and 19 months, respectively, for the sintering-plant and converter-plant treaters. The calculations are based upon the prevailing metal prices for the respective periods under consideration. At the sintering-plant treater, these profits have amounted to approximately 38 per cent. per annum of the total first cost of the treater. At the converter treater they have been about 56 per cent. of the first cost per annum.

Had the average metal prices for the past 10 years been used as a basis for these calculations, other factors remaining as they actually were, the sintering-plant treater would have shown a slight loss instead of profit, and the profit per annum at the converter treater would have been slightly less than 8 per cent.

L. D. Ricketts, New York, N. Y.—May I ask what is the purpose of the Cottrell treater in the converter plant?

B. L. Sackett.—The prime reason for both treaters was to abate the smoke, the familiar question of smoke litigation having arisen, which we expected to avoid by removing the solids from our escaping gases.

L. D. Ricketts.—After you began using the Cottrell treaters, and

recovering your lead in the form of sulfate, did you then begin converting the lead matte from your blast furnaces?

B. L. SACKETT.—No; we do not handle the fume from our lead converters in the Cottrell treaters. That goes to the baghouse, being a product which is completely neutralized. Our copper matte carries some lead, which we were anxious to recover, as well as to abate the smoke damage. It is only the copper-converter dust that we are catching in the treater, while the gas from the lead converter goes to the baghouse.

H. D. RANDALL,* Salt Lake City, Utah.—One important point, from the electrical standpoint, is the fact that the small machine of system A is apt to have a poor wave form as compared with the large machine in a central station. Also the limited electrostatic capacity of System A easily sets up harmonic vibrations of the higher frequencies. System B is electrically a part of the transmission system feeding it, and owing to its comparatively enormous electrostatic capacity, is not subject to the phenomenon of resonance. The comparison is analogous to a violin string against an aerial tram cable.

This, in itself, is the strongest argument in favor of system B; and now that central stations and transmission lines have such perfect voltage and frequency regulation, there really is an extremely small advantage, if any, to be attained from separate motor-generator sets.

E. P. MATHEWSON, New York, N. Y.—There are certain practical points connected with the operation of the Cottrell plants which I think should be discussed, although they are not directly brought up by the author of the paper.

In the early days of the Cottrell apparatus, they treated moist fumes or gases carrying material that could be precipitated—sulphuric acid was the first. The treating of dry gases seemed to be a problem. Lately, we have been gathering information from various plants which indicates that a certain amount of moisture in the gases is necessary for good precipitation of the dust. At one plant, a relative humidification of 42 per cent. is considered the best proportion. This has been obtained by sprays of water from the roof of the flue leading to the Cottrell apparatus, and since those sprays were put in, the results have shown a wonderful improvement. At the plant of the International Smelting Co. at Miami, the concentrates treated in the roasters to which the apparatus is applied contain so much moisture that the gases naturally have the proper proportion, and the results at that plant are extremely good.

When visiting a plant in the East not long ago, I noticed that the motor-generator set originally installed had been discarded, and a small synchronous motor had been put in to drive the rectifier. The superintendent explained that they took their power from a public service

* Manager, General Electric Co.

company, and had no trouble whatever from surges on the line, and no complaints at all from the power company since installing this synchronous motor, but that they had experienced no end of trouble in operating their Cottrell treater so long as they used a motor-generator set.

I called the attention of some of the superintendents at our various plants, which were using Cottrell treaters, to this fact, but it only seemed to touch a sore spot with them; it seemed that there had been a great deal of discussion among the superintendents of the various plants, as well as the electrical experts, on this point. Some of those who had been instrumental in designing installations thought that the dangers from surges were so great that the use of synchronous motors was absolutely unsafe, and that the possible saving of a few dollars should not be considered at all in the installation of the Cottrell treater; that the main thing was to get the dust precipitated, and that a slight increase of efficiency in the electrical end of the apparatus was not worthy of consideration.

On my present trip, I have found that the electrical expert in charge of the precipitation department in one of the plants has become fully convinced that the synchronous motor is the proper apparatus to install, and he demonstrated this to my untechnical eyes very clearly. They had four motor-generator sets on each side of the center of the building, with transformers corresponding to each set. Four of these motor-generator sets had been re-wound, so that they were practically synchronous motors, and were driving the rectifiers. The power was supplied by the Montana Power Co., a large source of power. I could see plainly the sparking above the transformers of the motor-generator sets, while there was no sparking whatever on the other side of the building where the synchronous motors were used. The voltage on the side where the sparking occurred was 25,000, and on the other side was 27,000 to 28,000. It proved to me that it would be wise for all who are contemplating putting in the Cottrell apparatus to consider carefully the difference in these two methods of applying the power to the rectifier.

There is one substance which non-ferrous metallurgists have always found to give a great deal of trouble in precipitating—that is zinc oxide. Numerous experiments have shown that the Cottrell apparatus is not adapted to the precipitation of zinc oxide where it occurs in large quantity. The zinc oxide, apparently—I now speak in a non-technical way—is precipitated in such form as to make a non-conductor, and the precipitation continues only a short time before its efficiency is greatly impaired. To save this substance it seems to be necessary to use some filtering agent, such as the baghouse.

F. H. VIETS,* New York City.—The Research Corporation has done

* Engineer with Research Corporation.

a great deal of work on the zinc oxide problem, and has built a treater at a brass company's plant in Connecticut to recover the zinc oxides from their casting shops. The principal factor in treating that fume is its humidification, which requires close adjustment. The last time I visited Torrington, last September, they were making about 85 per cent. recovery with this experimental unit.

In comparing the two systems of supplying power to precipitator circuits, a certain technical point requires explanation: System B, in which a large source of power supplies current of low voltage to precipitator circuits, is not nearly so liable to oscillations as is a small generator with its armature immediately adjacent to the primary of the transformer, which may act as a mirror to reflect back to the transformer any oscillations that may occur there. These oscillations may build up dangerous potentials on the secondary or high-voltage terminals of the transformer. The larger power system does not lend itself so readily to these oscillations; at least, it does not permit them to grow to dangerous proportions. System B has recently been improved so as to be controlled by a potential regulator on the primary, or low-voltage circuit, which gives very close regulation, and very efficient operation between the taps on the primary of the Cottrell transformers. These transformers are provided with taps on their primaries so as to give approximate voltage regulation. Between these taps, until recently, it has been the custom to use a series resistance to obtain voltage regulation.

I might comment briefly regarding recent observations on the rate of dust migration; I have in mind the case of fume-laden gas escaping from a 50-ton commercial kiln calcining alunite ore for the production of sulphate of potash. This gas contains not only very finely divided fume, but also some alum and coarse dust. When treating this gas in a pipe of 12 in. diameter by 15 ft. long, we find by filtration tests that over 99 per cent. of the solids entering the pipe are precipitated when a gas velocity of 7.5 ft. per sec. through the pipe is maintained. This means that the fume particles themselves are in the pipe for 2 sec. Considering the comparatively small number of particles entering near the center of the pipe, and assuming that they do not reach the pipe wall until they travel the whole length of the pipe, the particles must travel the 6-in. radius in 2 sec., and must have a velocity, due to electrical stresses, of 3 in. per sec. As a matter of fact, most of the dust is precipitated in the lower 6 ft. of the pipe, the upper 6 ft. recovering relatively small quantities of the dust.

B. L. Sackett.—Regarding humidification, we have found, in the case of our converter treater, that it is absolutely essential to add a

considerable quantity of water in the form of a fine mist; before adding that moisture we were not able to maintain anything approaching the proper voltage in the treater, and our recoveries were extremely low.

The gas going to the treater enters at a temperature, before being sprayed, of approximately 300° F. (150° C.); while the sprays do not lower the temperature very much, they seem to add sufficient moisture to accomplish the result required.

We have also recently learned that the Western Precipitation Co., of Los Angeles, has found that gases which have been rather ineffectively handled heretofore are now successfully treated with the aid of an efficient spraying system.

F. G. COTTRELL,* Washington, D. C.—It is interesting to notice that points raised tonight, as still under active discussion, were the centers of interest in a great deal of the work in the first few plants erected.

The use of the synchronous motor for the rectifier drive was naturally the first method adopted in the laboratory, and was carried into the initial commercial installations at Selby, and later at the Balaklala plant, although even at Selby, as development progressed, we tried out separate generators. At that time small a.-c. generators were not so easily obtainable as today. The development of wireless and other demands for small a.-c. generators have since brought the technique to the point where it is today, but at that time we had to content ourselves with a made-over four-pole d.-c. motor, having a special armature wound for it; but armature reaction in that case was very high. This, run as an a.-c. generator, would carry a lamp-load very nicely, but we could not get more than a few per cent. of its rating out of it on the rectifier load.

In the Balaklala plant we went over to the three-phase combination at the start, but found that, while this permitted us to get a little more precipitation out of each treater, the power consumption was greater in proportion than the gain in efficiency in the treater, and so we went back again to the single-phase.

After that, gradually, the commercial availability of independent small generator units came about, and they were adopted in some of the later plants, but that was mostly after I ceased to be in close contact with the work, and my knowledge of results is, therefore, largely second-hand.

Even the matter of zinc oxide came prominently to our attention at Balaklala. With the high-zinc ores which they smelted at certain times, we had difficulty with bone-dry precipitation, finding it hard to hold the voltage. We went into the question of humidification and rigged up sprays which we found helped us out. When the total zinc in the

* Chief Metallurgist, U. S. Bureau of Mines, and inventor of the process here under discussion.

ore was low, the acid in the roaster fumes was sufficient to make the deposit slightly conductive, but with high-zinc the oxide was sometimes in excess, and made trouble. We were inclined to the conclusion, at that time, that it would be necessary to have a slightly conducting precipitate, but our ideas as to just what was necessary were so often reversed in that early work that I became very cautious of drawing any general conclusions.

That was particularly true in the application of the process to cement works, where very high temperatures were to be encountered and there could be no appreciable condensation of acid or moisture. But Mr. Schmidt, at Riverside, was soon running his precipitators up to temperatures of 450° C., and even higher, with cement dust, which was about as dry and non-conductive, in the ordinary sense, as anything one could well imagine; yet he had no difficulty from these static troubles such as we had encountered with dry deposits at Balaklala.

We therefore had to revise to some extent our ideas of the significance of the non-conductive character of the fume. That still stands out as a rather interesting difference between cement dust, for example, and zinc oxide, at the same temperatures, one giving very much more trouble than the other. The essential difference in the electrical behavior of the two deposits seems most likely to be sought primarily in the fineness of their textures.

G. B. Rosenblatt,* Salt Lake City, Utah.—The choice between motor-generator sets and synchronous motors for driving the rectifier involves a point very often overlooked, which is the wave form of the power supplied to the rectifier itself.

The Anaconda Copper Mining Co. is installing the largest Cottrell treater in the world. They will treat dust from their copper roasting plant, and will employ a total of thirteen 75-k.v.a. outfits. After a rather lengthy investigation, with many trial runs on a more or less commercial design of treater, employing about 75 k.v.a., they decided on motor-generator sets. Personally I am not holding a brief for the motor-generator, but am merely transmitting to you information given to me by Mr. Murphy, of the Anaconda company.

Their investigations carefully covered systems A-1, and B, of Mr. Eschholz's paper. They gave no consideration to system A-2, because of the conjectured possibilities of regulation troubles. Their cost estimates led them to believe that the investment for system B, using induction regulators, as mentioned by Mr. Viets, would come to so little less than the investment for system A-1, that their appropriation was finally approved on the basis of system A-1, and the plant will be erected on that basis. They anticipate better operating conditions, less liability

* Electrical engineer.

of interruption, and more general satisfaction by using motor-generator sets than by using the power of the Montana Power Co. direct on synchronous motor-driven rectifiers. They are, however, putting in one unit according to system B, so that they may have some actual comparisons under commercial operating conditions.

In connection with their tests under commercial conditions, the Anaconda company made a great many oscillogram tests, the study of which led to the conclusion that if a motor-generator set could be obtained that would give as perfect a wave form as the average commercial power circuit, then the motor-generator set would afford superior operating conditions. If, on the other hand, the motor-generator set had shortcomings in its wave form, and embodied certain harmonics, then trouble might be looked for, not because of the motor-generator set itself, but because the wave form was not of the best. The smoothest operation may be expected with sets giving the most perfect wave form—more perfect than that of the average industrial power supply.

Anaconda has probably done as much as anyone toward developing the mechanical rectifier. They carefully examined the possibilities of other forms of electrical apparatus for obtaining uni-directional current, and considered everything, I believe, that could be furnished by the manufacturers. They gave particular attention to the hot cathode converter, or "kenotron," as it is called by its principal manufacturer. After testing it, and realizing its inherent disadvantages, they returned to the mechanically driven rectifier, and have developed it to a very high degree. They are now making and using the largest mechanically driven rectifier in the country; it is 42 in. in diameter, the largest previously developed being 36 or 37 in. They say they are getting excellent results from these 42-in. rectifiers.

E. E. THUM,* Salt Lake City, Utah.—In regard to some of the practical points on moisture content of fume and on precipitator construction brought out by Mr. Mathewson, it might be interesting to describe a plant about to be built at the Southwestern Portland Cement Co. at Victorville, Cal.

Dr. Cottrell spoke of the work of Mr. Walter Schmidt and his associates of the Western Precipitation Co. on hot cement dust. The Riverside plant, installed under their direction, is a very fine plant for the precipitation of hot dust. However, I was told by some of their men that while the precipitation made a fine recovery of dust from the furnace gases, it allowed a considerable quantity of the finest fume to get by. Unfortunately, the fume is richest in potash, and as you all know, cement-dust potash is an important and valuable commodity at the present time.

* Western Editor, *Chem. and Met. Eng.*

The Victorville people investigated different methods for recovering the potash volatilized from their cement kilns, and Mr. J. G. Dean, their chemical engineer, decided that he would install a humidification process rather than the electrical process of precipitation. Mr. Dean's experimental plant takes the hot gases, sprays them carefully and thoroughly, thus cooling them to about 110° C. by contact with cold water and by the evaporation of the atomized spray. These gases now contain a large percentage of water vapor and are passed through a condenser, there acting as a heating substance.

The condenser itself is rather unusual, the outside and supporting structure being made of reinforced concrete; the tubes and flue sheets are of steel, however. Within the condenser proper, a 24-in. vacuum is maintained above the weak solutions to be evaporated. Thus the humid gases passing through the tubes may be cooled to about 60° C. before discharge. Meanwhile the contained water vapor, condensing at 100° C. and below, would condense about the very small particles of potash as nuclei. The mist formed largely collects on the inside of the condenser tubes and trickles down into a sump, naturally carrying the potash in solution.

This works very nicely, but it is hard to collect mechanically the last particles of fog, and Mr. Dean found that even after the gases had passed through the condenser and been cooled and clarified, they still contained a considerable amount of unwetted potash particles. The amount varied somewhat—the potash recovery being perfect at times—yet under certain undetermined conditions of burning and wetting, the loss was large. Thus he finally decided that his humidification process was not as good as it might be, although it is producing about a ton of potassium sulfate a day.

Therefore he is now designing a Cottrell plant for treating these very cool, saturated gases which come through from the spray chambers and condensers, which is about as different from the gas at Riverside as one could imagine. Preliminary experiments show that the effluent from a precipitator treating these gases is sensibly potash-free at all times. The treater will contain concrete instead of iron pipes for the grounded electrode. Since the plant will precipitate a mist out of a saturated gas which is constantly cooling, the tubes will be always wet from this potash solution flowing down on the inside. This conducting film obviates the necessity of providing a metallic conductor for the grounded side of the apparatus. Since the gases are saturated on entering and cool during their passage, no evaporation of this film is possible, so no break in the circuit need be feared. Encrusting salts and growth of crystals are also impossible in the absence of any evaporation.

B. L. Sackett.—Mr. Thum brings out a very interesting point and one that we have found important. He speaks of the ease with

which the flue-dust, or the coarser particles of it, may be caught, and the difficulty of catching the finer particles.

As I understand it, the potash, as it occurs at the cement mills, is in the form of a fume; that is, has been formed by a chemical action, and is not a mechanical dust. At our plant we have found that the difficulties of precipitating a fume of this nature are far greater than with a straight flue-dust.

L. D. RICKETTS.—This point is well taken. In the treatment of converter gas at Miami, according to careful tests, we have very little copper escaping. The gas is hot, the solid particles contain a high percentage of copper and are practically all precipitated, yet the fume is dense white and practically all of the lead and zinc escapes. I wish to call attention, however, to the fact that the cooling of gases by admission of steam may be done satisfactorily so long as there is any zinc or lead oxide in the fume, but unless this is the case, free sulfuric acid will unite with the moisture to form a dilute solution which will destroy any iron work with which it comes in contact. At the Miami smelter we had to close down on account of a strike. It is probable that our steel stack discharging the reverberatory fumes had an internal coating of dust which was pasty with concentrated sulfuric acid, and that when the close-down came this acid absorbed moisture. In any event, it practically destroyed a portion of the stack.

E. R. WOLCOTT,* Los Angeles, Cal. (written discussion†).—When the deposit of dust or fume produced by electrostatic precipitation is non-conducting, the electrical charge is retained by the deposited particles. If the dielectric constant of these particles be large, the accumulated charge may attain a considerable potential.. In extreme cases this has been found to be of sufficient magnitude to produce ionization of the gases surrounding the deposits, an effect which is of course detrimental to satisfactory precipitation of the dust and fume. This "back ionization" has been photographed and reprints will appear shortly in the *Physical Review*. "Back ionization" is recognized by the fact that the voltage that can be maintained is lowered, sometimes as much as 50 per cent. of that which can be maintained with clean electrodes. This may be explained by considering that the "back ionization" increases the conductivity of the gases immediately surrounding the deposit, which is equivalent to moving the collecting electrode nearer to the discharge electrode, thus requiring less voltage to produce an arc.

Any means for making the deposits conducting, such as the addition of water, prevents this "lowering of the arcing voltage."

LINN BRADLEY,‡ New York, N. Y. (written discussion§).—In reading

---

* Western Precipitation Co.

† Received Sept. 1, 1918.

‡ Chief Engineer, and Acting Manager, Research Corporation.

§ Received Sept. 14, 1918.

Mr. Eschholz' paper on certain types of electrical equipment for the Cottrell process, it might be valuable to consider just what real differences there are between a separate motor-generator set and a synchronous-motor set. When it is seen that the difference is slight, the question arises as to whether the results may not depend upon other features than those brought out in the paper. In both types the precipitators are the same, the transformers and rectifiers are the same and, for good practice, the non-inductive resistance should be approximately the same.

The main differences are that in one case the alternating-current generator is in the precipitator power-house and the rectifier is driven by means of a mechanical coupling, while in the other case the alternating-current generator is in some remote power-house and the rectifier, for convenience, is driven by a synchronous motor which is merely a substitute for the mechanical coupling. In the former case, the voltage impressed upon the transformer may be varied both by action upon the generator field and by non-inductive resistance between the alternator and the transformer. In the latter case, voltage regulation is limited to one method, except for transformer taps, in usual practice, but experience has demonstrated that such regulation is indeed very effective and should be employed to some extent in either case.

Now if there is but slight difference in the regulating means, the difference in the size and characteristics of the alternators should receive more attention. It would seem that the large-sized and well designed alternator would be preferable as a source of the alternating current, and direct comparisons confirm this assumption. Of course, in order to get good results, the voltage delivered to the transformer should be steady, and if local conditions do not give steady voltage, due to intermittent operation of large motors on inadequate power circuits, it is necessary to correct the fault or else resort to motor-generator sets.

The facts that the precipitator load is not continuous, and that the load current is unusual, due to the laws of corona discharge, should be considered in designing a generator, since the rate of current flow at peak voltage is not the same as when other loads are employed. This accounts for the poor wave shape from an undersized or poorly designed alternator.

The Effect of Oxygen upon the Precipitation of Metals from Cyanide Solutions

Discussion of the paper of T. B. Crowe, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1279.

G. H. Clevenger, Colorado Springs, Colo.—Mr. Crowe's paper will be of great interest to cyanide operators, as it is a distinct new develop-

ment in cyanidation. After reading the paper it occurred to me that some of us had done practically the same thing some time ago, but without design and unconsciously. I refer particularly to the operation of some of the earlier types of vacuum filter, used in connection with a dry vacuum pump and a receiver, which is somewhat similar equipment to that employed by Mr. Crowe. However, we did not appreciate the good effects we were getting from such of this solution as was precipitated, and it has remained for Mr. Crowe to bring distinctly to our attention the advantages of removing air from cyanide solutions before precipitation. Full credit is therefore due him for this very clever improvement in the cyanide process.

J. V. N. DORR, New York, N. Y.—I think that Mr. Crowe's work has been the greatest single improvement on the chemical side of cyanidation within the past 15 years; other improvements within that time have been largely mechanical. Although he has shown us something that each of us should have known before, I feel that he has made a very definite and valuable contribution to the art.

A. L. BLOMFIELD, Colorado Springs, Colo.—When we first tried Mr. Crowe's process at the Golden Cycle mill, we supposed that the precipitation boxes would have to be kept covered, lest the air should again be dissolved in the solution and disturb the precipitation; however, we found that nothing that we did made the slightest difference. The application of the system had the immediate effect of doubling the capacity of the boxes and giving about 30 per cent. better tailings.

G. T. HANSEN,* Salt Lake City, Utah.—We have had occasion, within recent months, to heat pregnant solution to about 170° F., for the purpose of precipitating copper, before sending it to the zinc boxes. We found that heating accomplishes practically the same result, as regards removal of air, as applying a vacuum.

GEORGE M. TAYLOR,† Colorado Springs, Colo.—I would like to say, on behalf of Mr. Crowe, that at our two mills, the Victor and the Independence, where we were treating about 2000 tons of ore per day, there was a saving in zinc and cyanide of about $2500 a month, or $30,000 a year.

Roasting for Amalgamating and Cyaniding Cripple Creek Sulphotelluride Gold Ores

Discussion of the paper of A. L. BLOMFIELD and M. J. TROTT, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1265.

J. M. TIPPETT,‡ Colorado Springs, Colo.—There are several points

---

* Manager, Midvale Minerals Co.; Dayton Placer Recovery Corpn.

† Manager, Milling Department, Portland Gold Mining Co.

‡ Superintendent, Colorado Springs Milling Dept., Portland Gold Mining Co.

which offer ground for discussion, although the authors' indicated results leave small chance for argument. Under classification of the ores as they come to the mill, it will be noted that these are classified according to their lime contents. In previous years the classification was based upon sulfur contents, CaO not being considered; class A would be called the oxidized ore and class B the sulfides. Classification according to CaO is the first public indication that a decided change in the ore has necessitated improved methods of treatment. The very serious effect that CaO, even in small quantities, has upon extraction has been noted for some years.

The bedding of the ore is an interesting point; 66 per cent. of the ore, containing not more than 2 per cent. CaO, is called Bed A, while 34 per cent., containing over 2 per cent. CaO, goes to make Bed B. Why could not all the ore be put into one bed in which the CaO would average approximately 2½ per cent.? This would obviate the necessity for regulation, and would avoid poor roasts and loss of tonnage. No doubt there are good reasons why this is not done; first, can the two classes of ore be uniformly mixed? If this could be accomplished, then feed and heat conditions in the roaster could undoubtedly be regulated satisfactorily. Second, if the class A ores contained more than average sulfur, the ill effect of mixing it with a high CaO ore would be more pronounced.

Since roasting is the most important step in the treatment of these ores, it may pay to examine the different types of mechanical roasters in general use. These are the Holthoff straight-line, the Pierce turrett, and the Edwards. In the first two roasters, the rabbles carry the ore forward through the roasting hearth in practically the same manner. The Edwards roaster operates quite differently, in that the ore, on its passage through the roasting hearth, passes from one side of the roaster to the other many times before it is discharged, thereby increasing the time during which the ore is subjected to heat.

In describing the process of rabbling, it is stated that with 27 pairs of rabbles, making 3 r.p.m., the time the ore is passing through the roaster is 6 hr. In the Pierce and Holthoff roasters the maximum time is 3 hr. The greater length of time during which the ore is subjected to heat, and the rapid rabbling which exposes fresh surfaces of ore more frequently, are two important features of the Edwards roaster which the other types do not possess.

The remarkably poor sand residues are an indication of good roasting followed by careful classification. It would have been interesting to state the assay of the residues from the product finer than 100-mesh, which is approximately 30 to 50 per cent. of the total ore treated. Part of this product consists of what I would term the natural slime in the ore, existing as talc and vein matter, which generally contains values. It is this product, together with the portion finer than 100-mesh made in crushing before roasting, upon which it is difficult always to obtain a low-grade residue.

The Tailing Excavator at the Plant of the New Cornelia Copper Company, Ajo, Arizona

Discussion of the paper of FRANK MOELLER, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1229.

E. P. MATHEWSON, New York, N. Y.—I would like to call attention to the excellent plan for protecting the lining of the tanks from rough handling by the excavator. Many engineers, when considering mechanical excavators for lead-lined tanks, have been afraid that the machinery might get out of order and rip out the lining. This difficulty seems to have been entirely overcome in this installation, and those who have been responsible for its success deserve a great deal of credit.

A. F. CASE,* Cleveland, Ohio (written discussion†).—The application of the automatic unloader to the copper leaching process at Ajo was a very radical departure from the common use of this machine, inasmuch as the only previous use of this device has been in connection with the unloading of coal and ore from vessels on the Great Lakes.

There are many phases in connection with the unloading of ore from lake vessels that are not presented in the extraction of ore tailings from leaching vats. For instance, in unloading from boats, it is necessary to provide means to reach under the hatches to parts of the cargo hold which do not lie directly under the hatches, and to work in inaccessible places that do not exist in a leaching vat. These necessities require complications that could be very easily dispensed with in this new application. On this account the unloader, as applied to the New Cornelia plant, represents what is probably the simplest development of the machine that has ever been produced, and, manifestly, in its simplest form it could be expected to show results corresponding to its performances when installed with all of its complications.

One of the requirements of vessel unloading is extreme vertical travel, when the bucket is required to reach the bottom of the cargo hold, often 12 or 13 ft. below water-level, and discharge into a receptacle 30 ft. above the water. This was materially simplified at Ajo for the reason that the vertical travel was never more than 20 ft. This condition immediately resulted in the possibility of shortening the walking beam which carries the bucket leg, and, in fact, in entirely reducing the size of all the working parts of the trolley, walking beam, and bucket leg, as far as reaches were concerned.

* Engineer, Coal & Ore Handling Dept. of the Wellman-Seaver-Morgan Co.

† Received Oct. 7, 1918.

The bucket is interesting on account of its mechanical operation. The shells of this bucket are carried on heavy cast-steel supporting arms which are attached to the bucket pins to which the shells are in turn attached; the arms, in turn, being carried on roller-mounted pins which are guided by horizontal and vertical guides in the lower end of the bucket leg. The purpose of this arrangement is to control the path of the cutting edge of the bucket shell so that a sharp edge is at all times presented to the material in which the bucket is working, thus minimizing the effort required to close the shells.

In this machine, three chain drums are required for opening and closing the bucket; two closing drums located on the outside of the bucket leg, and one opening drum, located in the center of the leg, all on the same shaft. As the chains lead to these drums from opposite sides, the opening and closing of the bucket is accomplished by simply reversing the direction of rotation. In order to compensate for the changes of the relative lengths of the chains in opening and closing, the drums are made cam-shaped.

The immense closing pressure required at the cutting lips is obtained by the introduction of gearing connecting the chain drums to a power wheel located in the bucket leg. The upper shaft, carrying the power wheel, is rotated by ropes which lead to the bucket-operating mechanism in the rear end of the walking-beam.

In addition to the bucket-operating mechanism, all of the machinery for operating the rotating and beam-hoist motions are also located in the back of the walking-beam. In this position they act as a counterweight to counterbalance the weight of the bucket parts. This feature of the machine is one that is important, as it is possible in this way to secure accurate control because the balance of the walking beam can be delicately adjusted.

We have mentioned the motion of rotation, which is also applied to the bucket. This permits the operator to rotate the bucket at right angles to the normal position, thus enabling the bucket to reach into places that would otherwise be inaccessible.

It might be interesting to note the power requirements, in terms of motor capacities, of this equipment. The motors have the following ratings:

Bucket hoist	150 hp.
Bucket closing	100 hp.
Trolley travel	100 hp.
Bridge travel	100 hp.
Rotating	15 hp.

These motors are all provided with magnetic braking control, with the exception of the rotating motor.

The conditions existing at Ajo required some provision for moving the machine transversely, in order that it might be used over a duplicate set of vats. For this purpose a transfer table was introduced. The table consists simply of a structural frame carrying a section of the excavator runway, and provided with trucks which travel at right angles to the main runways. The transfer runways are about 5 ft. below the main tracks. Electric conductors are provided for supplying current to the motor for moving the table, as well as short sections of main conductor for supplying current to the excavator when running on and off the table. An 80-hp. motor is provided for moving the transfer table.

Radium

Discussion of the paper of RICHARD B. MOORE, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1165.

W. A. SCHLESINGER,* Denver, Colo.—Two problems are of great interest to the radium manufacturer at the present time: The first is to perfect a process, more efficient and more economical, which is capable of treating a greater variety of ores. Practically all the radium now manufactured in the United States is extracted from carnotite ores and these vary a great deal according to their location. The amount of sulfates contained in the ore is of particular importance, and any straight acid-leaching method, such as developed by the Bureau of Mines, becomes prohibitive when the ore contains more than 0.5 per cent. of sulfates, as the sulfates go into solution and naturally precipitate the radium as insoluble radium sulfate. Since the amount of ore obtained from any one claim is usually comparatively small, it is necessary to work a number of claims in different localities, and a process, in order to be commercially satisfactory, should handle all of these ores. In other words, it would be entirely unprofitable for radium manufacturers to employ any process which cannot treat any but sulfate-free ores. He must deal with carnotite containing appreciable amounts of sulfates, and must be able to work this in with the other ores. Carbonaceous ores from certain sections in Utah, which are known to contain as much as 10 per cent. and more of volatile matters, are prone to a nitric acid-leaching process.

The second problem relates to the treatment of concentrates. There is no doubt that a very large amount of low-grade ore, containing less than 0.75 per cent. uranium oxide, is available. It has been demonstrated that these ores can be concentrated, but there is still room for research

* The Radium Company of Colorado, Inc. (Formerly The Schlesinger Radium Co.)

work to develop a process that will efficiently handle such concentrates. The straight acid-leaching method, if used with concentrates, is confronted by difficulties in filtering. The concentrates are naturally very fine, and when leached with acid will easily clog the filtering medium.

It was suggested that, by mixing concentrates with straight ore ground to 20 mesh, one could overcome the filtering difficulties, with a straight acid-leaching method on sulfate-free ores, by the use of pressure filters, and obtain an extraction of approximately 75 per cent. If, however, this method gives an extraction of 95 per cent. on the straight ore alone, and if by mixing with 25 per cent. of concentrates the combined extraction is reduced to 75 per cent., no advantage is gained by this procedure.

A considerable amount of radium has lately been used in the manufacture of self-luminous compounds, consisting of specially prepared zinc sulfide mixed with varying amounts of radium. The powder is then, with the help of a suitable varnish, made into a paint and applied with a brush. The character of the varnish varies according to the use to which one wishes to put the paint, and whether or not the paint has to withstand the action of alcohol, glycerine, or water. We have applied self-luminous radium preparations to over half a million Government instruments since the outbreak of the war. Units for luminosity measurements have also been developed, and the luminosity of these paints is now being measured in micro-lamberts, which are a fraction of a candle power.

The suggested use of mesothorium is very interesting, but little has been published and few experiments have been made in this country to show whether mesothorium is as efficient as radium when mixed with zinc sulfide for luminous paint. Experimental data should be collected to show the rate of deterioration of zinc sulfide when mixed with mesothorium.

I do not think a shortage of radium will occur for years to come, especially in view of the low-grade deposits. The amount of radium used for luminous paints, even now, is comparatively small; probably 500 milligrams is being used every month for the manufacture of luminous paint for war purposes in this country.

R. B. Moore.—I have been asked to say a few words about Dr. Douglas in his connection with radium. The radium I have showed you was some which was produced by the National Radium Institute, in which Dr. Douglas was greatly interested; in fact, he was one of those who financed that organization. He did this mainly for two reasons: first, as a philanthropic object for the alleviation of suffering from cancer, and secondly, because of his interest in scientific and technical progress of all kinds.

At that time the extraction of radium from ores had been only slightly investigated; practically nothing was known about it in this country. All of the radium he obtained as his share in the operations went to the

Memorial Hospital, in New York, and is still there as a gift to the Hospital. Dr. Douglas, therefore, accomplished the two objects he had in mind—he helped to make possible a study of the technical methods of extraction and at the same time gave his share of the radium obtained for research work in cancer treatment.

An Interpretation of the So-called Paraffin Dirt of the Gulf Coast Oil Fields

Discussion of the paper of ALBERT D. BROKAW, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 136, April, 1918, pp. 947 to 950.

W. G. MATTESON,* Fort Worth, Tex. (written discussion†).—Dr. Brokaw has evidently given a great deal of time and study to this phenomenon and his conclusions seem sound and logical.

Mr. Lee Hager was probably the first geologist of repute to attach any great importance to the occurrence of paraffin dirt in connection with the Gulf Coast oil-producing salt domes. The writer has been reliably informed that through his discussion, the idea was promulgated that the presence of this so-called paraffin dirt was one of the most important and reliable indications of the presence of an oil-producing salt dome. Despite very strong evidence to the contrary, Hager evidently still has considerable confidence in this theory, as brought forth in his discussion[1] of Dr. Brokaw's paper. Hager here gives all the paraffin dirt occurrences known to him, and adds, "Fifteen of these localities, including practically all of the greatest fields, have produced oil in some quantity."

The acceptance of the list of occurrences as submitted by Hager depends upon what material we are justified in including under the term "paraffin dirt." If we agree to a broad classification, whereby paraffin dirt is to include all spongy, earthy, decomposed, vegetable material, or spongy soil impregnated with the same, then Hager's list will have to be not only accepted but perhaps enlarged. On the other hand, if we confine ourselves to a strict interpretation of the substance known as paraffin dirt, based upon typical occurrences, general understanding, and application, several of Hager's occurrences will be seriously questioned by many geologists. The typical material is excellently described by Hager as a dirt or soil-like substance "resilient to the step, like rubber, which falls apart in small squares when dug. Intimately mixed with the soil itself and between the cracks and joint planes is a yellow, jelly-like

---

* Consulting Petroleum Geologist and Engineer.

† Received Sept. 24, 1916.

[1] *Bulletin* No. 140 (Aug. 1918) 1158.

substance resembling paraffin or soft, yellow beeswax." The material is generally brownish to dark brown in color.

Many able geologists, who have carefully investigated the territory at Anse La Butte, have failed to observe any such material as above described within "100 ft. of the best well in the field." A deposit of spongy, vegetable matter was found near the heart of the field, but it in no way resembled paraffin dirt. In a personal communication to the writer, William Kennedy states that he could not find any of the dirt in the proved part of the field, but observed some peat-like material considerably to the east, where several dry holes had been drilled in the vicinity of the occurrence. In the Jennings field, some peculiar clays were observed, and again at Terry, some slimy, stinking vegetable material and soil were found which in no way resembled paraffin dirt, even in the altered form described by Hager. Here again several dry holes were drilled in close proximity to this substance. William Kennedy, one of the ablest and most experienced Gulf Coast investigators, has stated that he was never able to find any evidence of paraffin dirt near or around Spindle Top, although he has examined that area carefully several times.

As to the statement that this dirt is found close to the discovery well at Humble, C. E. Barrett did not drill the discovery well; his well went into gypsum and was abandoned. D. R. Beatty, in 1905, brought in the first commercial producer at Humble. Some paraffin dirt has been found at Humble, however, although the occurrence had nothing to do with the location and discovery of the dome. Some quantity of typical material occurs at Hackberry, yet five or six wells, 1600 to 2200 ft. in depth, failed to obtain even gas.

Hager claims that Batson was discovered through presence of this paraffin dirt, the discovery well being located close to its outcrop. It is doubtful if Judge Douglass would have made his location in the vicinity of the dirt, were it not for the quantity of gas escaping near there. In view of many subsequent drilling failures on evidence of this paraffin dirt, too much weight should not be given the Batson occurrence.

It is true that small quantities of paraffin dirt are found in the vicinity of several oil-producing salt domes, but it is most significant that, with possibly the exception of Batson, cited by Hager, none of these domes was located and drilled by reason of the presence of this dirt. The dome or mound-like character of the area, or other topographic features, the presence of sour springs, salt springs, asphalt seeps, gas seepages, etc., this was the evidence by which 95 per cent. of the oil-producing salt domes were located and drilled.

What has been the result when well locations have been made according to the presence of paraffin dirt only, and without some of the more reliable and conclusive evidence such as has just been cited? In

Chambers County and at Bayou Caster, wells drilled near paraffin dirt failed to find oil in commercial quantity and were abandoned. Wells drilled at the eastern vicinity of Anse La Butte, where the dirt is said to occur, were abandoned as failures. The largest and most characteristic deposit of this dirt is found in Sabine County, south of Low Creek, in the vicinity of Sabinetown. Wells drilled on the evidence of this dirt here found only some gas, but no oil in commercial quantity. These are a few of the instances the writer had in mind when making the statement[2] to which Hager takes exception, that "where drilling has take place in the vicinity of this paraffin dirt, the results have been a failure." And even Hager's confidence in this material must have undergone some change when he has been reliably reported as turning down the Columbia field.

As to Hager's concluding arguments,[3] he bases the importance of the paraffin dirt as an indication of the nearby presence of oil on his contention that the gas so intimately concerned in the formation of this dirt is *petroleum gas*. Why petroleum gas? Would not methane or marsh gas serve equally well? Owing to its widespread occurrence in the Gulf Coastal plain, would not marsh gas be a more common and plausible source? Does not the fact that this paraffin dirt is found widely scattered, and in places where drilling has failed to yield oil in anything like commercial quantity, strengthen the evidence that marsh gas is more concerned in the formation of the dirt than petroleum gas? In escaping, marsh gas may be diffused over a small area at the surface instead of issuing from one particular spot. Would not this method of escape explain the areal extent of these paraffin dirt deposits better than if the escaping gas were confined to one vent? As for quantity of gas, the writer has observed places in the Gulf Coastal plain where marsh gas has been escaping in considerable and undiminished volume for many years. Moreover, have we any direct evidence to prove that the formation of this dirt is the product of ages? And if petroleum gas is the gas concerned in the process of formation, why do we not find this paraffin dirt extending to considerable depth along the passage of escape taken by the petroleum gas?

In concluding this discussion, the writer wishes to emphasize the following points:

1. Certain spongy soils, highly impregnated with vegetable matter, should not be mistaken for paraffin dirt.

2. Some reported important occurrences of paraffin dirt are not the typical dirt, but the material referred to in 1.

3. Small quantities of paraffin dirt have been observed at a few of

---

[2] *Bulletin* No. 136 (April, 1918) 834.

[3] *Bulletin* No. 140 (Aug., 1918) 1162.

the important oil-producing salt domes along the Gulf coast, but none of these domes, with the possible exception of Batson, was discovered and drilled on the evidence of this paraffin dirt.

4. Drilling, based solely on the presence of paraffin dirt and often where this dirt has been observed most characteristically and in unusual quantity, has almost invariably failed to open up new commercial fields, or to develop oil in anything like paying quantities. Thousands of dollars have already been lost on such propositions.

5. Paraffin dirt as an indicator of the presence of domes and the commercial accumulation of oil, is so erratic and unreliable as to be of little concrete value to the careful, conservative investigator.

The Byproduct Coke Oven and its Products

Discussion of the paper of WILLIAM HUTTON BLAUVELT, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, p. 597.

GRAHAM BRIGHT,* East Pittsburgh, Pa.—Bee-hive coke ovens are usually located at the mines, where the gases from the ovens are not strongly objectionable because the communities are not thickly built up. The byproduct oven will naturally be located near centers of industry, to which the coal can be brought from different directions and desirable mixtures can be made; where also the byproducts can be readily marketed, while the gas can be utilized for industrial and domestic purposes.

Not much thought seems to have been given to the gases escaping from the byproduct coke oven, which are more or less objectionable in thickly populated sections. When the byproduct oven shall have been more widely installed, this question is likely to become serious, and it will be necessary to apply remedies. May I ask what has been done, or is going to be done, in this direction?

S. A. MOSS,† Lynn, Mass.—One cause of escaping gas is that the gas exhausters do not supply the proper suction. If a satisfactory regulating governor is applied and the correct kind of gas exhauster is used, the trouble will be eliminated.

J. I. THOMPSON,‡ Pittsburgh, Pa.—The Koppers Co. has made a careful study of the question of smoke prevention. The smoke caused by the operation of the byproduct coke ovens is infinitely less than that caused by bee-hive ovens.

The difficulties in preventing the last traces of smoke in byproduct

---

* Westinghouse Electric and Manufacturing Co.

† Mechanical Engineer.

‡ Chief Engineer, H. Koppers Co.

ovens are largely mechanical but are serious difficulties, considering that it is necessary to charge the 10 to 15 tons of coal into a heated oven in such a manner that no gas shall escape. The principal loss of gas occurs during this operation of charging the ovens when it is not possible to conduct all of the gas into the mains leading to the byproduct apparatus.

A great deal of study is being given to this matter, and the Koppers Co. has constructed a plant in St. Paul which is equipped with certain devices for correcting this nuisance. The method employed is to carry a portion of the escaping gases into the stack and discharge them high enough above the ground so that they will not be objectionable, while the remainder will be recovered and led into the byproduct apparatus.

The Use of Coal in Pulverized Form

Discussion of the paper of H. R. Collins, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 136, April, 1918, p. 955.

E. A. Holbrook,* Urbana, Ill.—To those who have followed the development of powdered coal two questions often occur. First, as to the moisture in the coal. In Illinois we recognize that the bituminous coals contain about 12 to 15 per cent. of what we call "contained moisture," that is, the moisture is present in the coal although this may appear absolutely dry and dusty. In addition, the surface moisture may be present in any amount. I would like to ask what is the relative effect of these two forms of moisture upon the work of pulverizing. Does Mr. Collins refer to the contained moisture or to the surface moisture in estimating the degree to which the coal must be dried?

H. R. Collins.—In the lignite coals, of which this country possesses a great deal and is beginning to develop them to considerable extent, the "contained" or "combined" moisture does not trouble us; we have no difficulty in reducing lignites to a high degree of fineness. But when dealing with bituminous, sub-bituminous, or semi-bituminous, we prefer to reduce the combined moisture as well as the hydroscopic moisture as far as possible.

We have recently put into operation, at a plant, furnaces and boilers consuming the lignite from northern New Mexico, which contains between 4 and 5 per cent. moisture as we pulverize and burn it.

The evaporating efficiencies under the boilers have been so remarkable that we wish to check the results half a dozen times before quoting them. We have also just started two boilers at the Garfield smelter, and have obtained the same high efficiencies.

---

* Supervising Mining Engineer and Metallurgist, U. S. Bureau of Mines.

E. A. HOLBROOK.—My second question relates to the objectionable slagging that sometimes occurs when pulverized bituminous coals are used as boiler fuel. The first pulverized-coal installation I saw in this country was of Bettington boilers at one of the Nova Scotia coal mines; there their great difficulty arose from the slagging of the ash due to the exceedingly high temperatures.

H. R. COLLINS.—Slag, as a rule, does not seriously affect metallurgical work, but in boiler practice it has given a lot of trouble and required a great deal of study and experiment. Temperature we were all familiar with, but failed in the beginning to take into account the expansion of gases. If the air goes into the furnace preheated, its volume at that temperature must be taken into account. For many years, furnaces were made too small, and when we began to develop these high temperatures we were continually burning out our brick-work, especially when it became necessary, as in electric generating plants, to drive the boilers at 200 to 225 per cent. of their rated capacity. The driving of the gases through restricted passages, at high temperature and high velocity, caused almost complete erosion of fire-bricks in from 2 to 3 weeks.

After a great deal of experiment, we found that if the velocity of the heated gases were reduced, erosion of the fire-brick ceased. In boiler installations, in order to complete the combustion of the pulverized fuel in suspension, we increase the volume of the combustion chambers.

The disadvantage of slagging has been greatly reduced by the practice of burning all the carbon in the fuel while in suspension, so that partly burned carbon is not projected against the refractories; and the passing of a column of cooler air from the outside through the bottom of the fire-box diminishes slagging. To increase our CO_2 to 16 or 17 per cent., we diminish the air going through the burners and let it go in at the bottom. This seems to eliminate slagging, and the ash deposited is fine and flocculent, resembling discolored flour.

WALTER GRAHAM,* Washington, D. C.—Regarding the application of pulverized coal to the open-hearth steel furnace, Mr. Collins states that the sulfur in the coal will not detract from the quality of the steel, and that the ash does not interfere in the regenerators.

At present it is my special task to stimulate the production of steel and improve its quality. I am trying to help increase the quantity of steel by 10 per cent., which will be about 3,200,000 tons, or equivalent to the output of several large steel works.

The use of gas coal has not been very successful lately in steel mills. I found one works in which they were making only about 20 per cent. of their potential production, the trouble being mostly with the gas coal,

*Captain, Ordnance Department, U. S. Army.

which was unscreened. They were taking the gas from one furnace 10 hr. to get another one out in 24 hr., when the time should have been 10 or 12 hr.; they were making 9 heats instead of 21. Two of those were high in sulfur, and were taken for nut steel; of the seven others we rejected 65 per cent., leaving less than 20 per cent. of the potential output. The cause was mostly the poor preparation of the coal.

While I was in the Fuel Administration, I was made a special investigator to report on the cleaning of coal. On going through the records of the Bureau of Mines and the Geological Survey, I estimated that there is 5 per cent. more ash and sulfur in the coal this year than before the war; this means 12.5 per cent. less efficiency. It also means 650,000 extra carloads of ash and sulfur to be carried this year, requiring 50,000 coal cars; a loss of 12.5 per cent. efficiency is equivalent to 85,000,000 tons of coal, which is greater than our shortage.

The importance of cleaner coal is most pressing. I see the necessity for it everywhere, and particularly in the steel works, where it affects the quality of pig iron, the quality of coke, and the quality and quantity of steel. It increases the consumption of manganese in the steel furnace and of limestone in the blast furnace, and is cutting down production.

H. R. COLLINS.—Copper is one of the most active absorbers of sulfur that we know. A year and a half ago, we made a trial of pulverized coal on one of the American Smelting and Refining Company's copper furnaces in New Jersey, melting electrolytic copper. The tests lasted a week, and the analysis of the resulting copper showed no increase in sulfur. The same seems to hold true in steel. The act of burning the coal in suspension, in such a finely divided state, seems to consume the sulfides, although sulfates are not effected.

BRADLEY STOUGHTON, New York.—It is embarrassing for a steel man, in a large company of coal men, to say that we blame the sulfur in our steel partly on the coal, but nevertheless we do. The statement that Mr. Collins has just made is contrary to all the experience of steel men, and I shall be very happy if he will show us that steel does not absorb a part of the sulfur that goes into the furnace in pulverized fuel, or in oil, or in gas. Any evidence that Mr. Collins has on this point ought to be presented, because it is very important. I do not think that the copper experiment is quite conclusive as to the behavior of steel.

MILNOR ROBERTS,* Seattle, Wash.—Coal is being burned in pulverized form in the State of Washington in large-scale operations under the general conditions described by Mr. Collins. The coals that are being used are described in F. A. Hill's paper on "Coal Mining in Washington."[1] The powdered coal is being used for heating, smelting and power generation.

* Dean, College of Mines, University of Washington.

[1] *Bulletin* 136 (April, 1918) 951.

The Puget Sound Traction, Light and Power Company's Western Avenue plant in Seattle, a central heating station containing 10 boilers aggregating 4100 hp., has replaced oil fuel with pulverized coal. The pulverizing plant is located directly across the Avenue, the product being conveyed under ground and delivered to feeding bins above the boilers. Coal prepared at this plant is also distributed by truck to a number of large buildings having their own heating plants. The Western Avenue station is believed by its operators to be the largest of its kind that is using powdered coal today.

Fifteen tests of Washington coals, in lots of about 10 tons, have recently been made at the Western Avenue station in a 300-hp. Babcock & Wilcox boiler. The results, as reported by the chief engineer, are in part as follows: Evaporation per pound of coal, from and at 212° F., 8 to 9.3 lb. Carbon dioxide in flue gas, 13 to 17 per cent. B.t.u. per pound of powdered coal, 9688 to 12,734. Efficiency, 65 to 77 per cent. In operation, an evaporation of 8.5 lb. is expected. By way of comparison, it may be noted that the same company's Post Street power plant, where chain-grate stokers are used, with similar coals, under boilers aggregating 3000 hp., shows an evaporation of about 6 lb. per pound of coal.

Steam power plants in which coal is burned in pulverized form are in operation at the Black Diamond coal mines, where nine boilers are in commission, and at Newcastle, where the plant has been partly converted to the method. At the Tacoma Smelter pulverized coal has replaced oil in a reverberatory smelting furnace which treats copper ores.

It is feasible to use any of the Washington coals in powdered form, but the lignite and the sub-bituminous types have proved especially suitable. Coals of these grades, in fine sizes, may be bought on contract at low prices because they form practically a waste product.

Erskine Ramsay, Birmingham, Ala.—Captain Graham's interesting remarks about the country's great necessity for clean coal bring to my mind certain advances made along this line in Alabama.

There is a strong demand today for some comprehensive means of adequately and properly determining the daily quality of the particular coal sent out by each and every individual miner, it being important that the means adopted shall show the percentages of slack, lump, and slate contained in the cars sampled, and it is essential that the cars thus sampled shall constitute a large proportion of the total cars dumped daily. Heretofore there has been no way to accomplish this.

The system in use at many Alabama mines consists simply of selecting at random from time to time, during each day, as many as, say, a dozen mine cars from various miners, the entire contents of each being laboriously hand-picked in order to ascertain just how much slate is in each one. The amount of slate found in each car picked is regarded

as the fair average for all of the cars coming from the particular miner loading the sampled car.

One or two slate pickers are daily employed at the average mine. They pick by hand an average of about 1 per cent. of the total mine output, but, of course, a varying and indefinite proportion of the cars loaded by each miner. Fixed penalties, known as dockages, are made for given percentages of slate. At a few mines, however, as an inducement for the loading of clean coal, where the car picked is found to contain less slate than a fixed amount, a bonus or premium is given, which offsets in some degree the amount docked. As most of the mines do not give any bonus or in any way reward the loading of clean coal, there is not any special incentive for the loading of coal free from slate. With the daily picking of such small proportions of the total mine cars dumped, some of the miners may feel that they can safely ignore such examinations, and that dirty coal would run a good chance of not being detected.

The old system is uncertain and inadequate, for the reason that cars selected at such long intervals cannot possibly give the true average quality of all coal loaded by each individual miner. Sample cars from the same miner, selected at different times during the day, show varying percentages of both slate and slack, as cars loaded during the early part of the day's work, and especially from rooms, contain relatively high percentages of lump and low percentages of slate, as compared with those loaded later in the day when the places are being cleaned up.

Slate pickers are often paid so much per can of slate found in the cars they pick. This leads to confusion and discontent. The miners protest that the present haphazard system, as between man and man, is unfair, and it results in frequent and troublesome disputes between the management and the men.

The Ramsay mine-run sampler, which we are using, avoids such annoying disputes and disagreements, and secures without friction or trouble the loading of a much more satisfactory and uniform grade of clean coal. Improved conditions are brought about not only without additional expense, but even at less total cost. Our experience during the past 3 years has proved advantageous to both the operator and the clean coal miner. The miner who is compelled to improve the character of his work or go elsewhere is the one who habitually loads dirty coal. If he objects to this new plan of taking a fair sample from each of a large number of his cars, it is because it plainly and positively shows the character of coal he loads every day. One of the best points, however, is that, under our new system, a man loading clean coal is not subjected to a penalty on account of the dirty coal loaded by his fellow miner.

In order that every miner may know every day what grade of coal

each miner is loading, the sample record as to both slate and slack is entered daily on a public slate tally sheet kept at the mine, and at the end of the month each man's monthly average is also shown. The moral effect of making this information public is good, even without penalties, as no man wants to be found at the foot of his class. When a plan entailing a penalty or the giving of a premium is in effect, the averages are used in determining the amounts.

In using our new sampler system, relatively small samples, running from 100 to 200 lb., are taken from a large portion of the total mine cars dumped daily. The apparatus we have in operation takes these small fair samples from the whole contents of a mine car. These samples are screened, so that the slate is quickly and thoroughly picked by hand, using the screen as a picking belt. When it is borne in mind that the time and labor required to hand-pick one of our 3-ton cars of coal, under the old way of sampling, is sufficient with the new plan to screen, pick, and record the 100-lb. samples from at least 75 different mine cars, the advantage of the sampler is apparent.

At our Banner mine, it formerly required three men to pick the entire coal contained in a limited number of mine cars, while with our present system three men take and pick the great number of relatively small samples. Formerly eight men were required at the picking belt, but now four men easily do the work. The efficiency and economy of our new arrangement is found in the surprising fact that the total amount of refuse going to the waste dump fell off 50 per cent. shortly after the sampler was installed. To put it differently, the refuse going to the waste dump, before the installation of the sampler, ran over 20 per cent. of the total output of the mine and this is now less than 10 per cent. On the mine's total monthly output, 40,000 tons, we get a saving of more than 4000 tons of coal, f.o.b. railroad cars, which means that 4000 tons of slate are now being kept in the rooms and in its place 4000 tons of coal are sent out.

The sampler screen speeds up the actual treatment of the samples, and gives a record of the percentages of slack and lump, thereby showing what miners are shooting their coal to pieces. This feature is especially valuable at mines loading domestic coal.

The sampler has a series of pockets or compartments arranged transversely in the bottom of the tipple chute. The covers permit any sample pocket to be opened at will, thus varying the portion of the car from which the sample is taken, as the pocket can be opened at any time during the flow of the stream of coal from the car. In this way samples are taken from any part of the car. Five samples are taken by the New Castle machine just as fast as the cars can be dumped and without interfering in any way with the speed of the dumping operation. The samples are taken, screened, picked, weighed, and recorded at the rate

of one every 2 minutes. With the data furnished by the sampler, the operator knows what parts of the mine, if any, are giving the best product, and he can therefore make changes of correction where necessary. Where the coal is loaded in the railroad cars as run-of-mine, the tally sheet record not only shows the quality of coal loaded in every railroad car but it actually shows who loaded the coal.

H. N. EAVENSON, Gary, W. Va.—Mr. Collins states that he can burn any fuel having from 1.5 to 3 per cent. of volatile matter, but that, for almost all purposes, he prefers fuel having 35 per cent. or more. The highest-grade coal that we use is the semi-bituminous coal, which is low-volatile (about 15 per cent. to 20 per cent.) and low-sulfur, but high-heat content coal, running as high as 15,500 B.t.u. per pound. I would like to know what his experience with such coals has been; whether they are less desirable than the higher-volatile coals on account of trouble with the brick work, or in operation, or on account of the higher price usually charged for those coals.

H. R. COLLINS.—The low-volatile anthracites can be burned satisfactorily only in a special furnace, for the simple reason that the temperature must be brought high enough to burn the carbon as it enters. As to the higher-volatile coals, there is a point between the low-volatile and those having the percentage of volatiles mentioned, at which some slight trouble is encountered, but there is no danger of not being able to burn any of it. The only annoyance occurs when designing the proper fireboxes for fuels ranging from 1.5 up to 25 per cent. volatiles. The size of the returning arch must be reduced as the volatiles increase. With coal having 25 per cent. volatile, there is no trouble in burning it in an open chamber.

Coal Mining in Washington

Discussion of the paper of F. A. HILL, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 136, April, 1918, p. 951.

MILNOR ROBERTS,* Seattle, Wash. (written discussion†).—The coal fields of Washington, on which Mr. F. A. Hill's paper gives much detailed information, lie on the western slope of the Cascade Range, which extends north and south through the State just west of its center. The mines are on the lower half of the slope, the lignite fields of Lewis and Thurston Counties extending into valleys and low hills west of the mountains. An exception is to be noted in the case of the Roslyn field, a small but important area which lies on the eastern slope.

---

* Dean, College of Mines, University of Washington.

† Received Sept. 13, 1918.

The degree of alteration which the coal of a particular field in Washington has undergone may be gaged roughly by the position of the field with reference to the Cascade Mountains. The lignites of Tenino, Tono and Castle Rock, on the railway line connecting Seattle and Portland, all occur in a region of low relief, in which the Eocene coal meaures have suffered only minor disturbances. Sub-bituminous coals, which are most typical of the State, occur in the foothills, as at Renton and Newcastle. Coals high in fixed carbon are found farther in the mountains, where the measures have been sharply tilted and folded, for example at Black Diamond and Carbonado. The two anthracite fields are located still higher, in rugged mountains where outcrops appear both in deep gorges and on ridges at elevations approaching 5000 feet.

The costs of mining appear erratic when compared with those in other States. The lignites, as a rule, are mined cheaply, as stated in the paper, but so also are certain other beds which lie at convenient angles of dip, have good roof, and contain gravity coal. Naturally, such beds already discovered have been attacked first.

Washington coals are being burned successfully in pulverized form in a copper-smelting reverberatory, in the heating plants of several buildings, and in a large central heating station in Seattle. It is important for the coal-mining industry that uses should be found for the fine sizes of coal; these products are considerable in amount, but scarcely any demand exists for them at present. Briquets have been in use for domestic purposes for several years, and now the use of pulverized coal seems likely to offer a market for the fine sizes in the lignite and subbituminous grades.

The use of pulverized coal in boiler plants, to be located at the mines, is a possible source of power to compete in the cities of the Puget Sound region with hydro-electric power. Washington has greater water-power resources than any other State in the Union, but it seems probable that coals of the cheaper grades and sizes can produce power in competition with hydro-electric plants, excepting those that enjoy unusually low costs. In future this comparison should prove still more favorable to coal, for the reason that water wheels have already reached a very high degree of efficiency, while power derived from steam falls far short of the ideal. Both the Puget Sound Traction Light and Power Co. and the City of Seattle have steam-power auxiliaries to their large hydro-electric power systems.

The coal fields of Washington are the only extensive ones in the Pacific Coast States; they supply a large territory and the coal is used for a wide variety of purposes, from gas making to bunkering steamers. Under such conditions it is unusually important that the coal be mined with the least waste, prepared as carefully as possible, and used to the best advantage. The Pacific Northwest Station of the United States

Bureau of Mines, located at the College of Mines, University of Washington, and working in coöperation with the College, is giving especial attention to these three phases of the industry.

Carbocoal

Discussion of the paper of C. T. MALCOLMSON, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 137, May, 1918, p. 971.

F. W. SPERR, JR.,* Pittsburgh, Pa.—Mr. Malcolmson states that the Carbocoal process produces ammonium sulfate in excess of that normally recovered in the ordinary byproduct coke process. Table 3 indicates that 20,000 to 25,000 lb. of sulfate of ammonia are obtained in carbonizing 1000 tons of Clinchfield coal. This is a high-grade coal and yields from 26 to 28 lb. of ammonium sulfate per ton in a modern byproduct coke oven. On the next page, 21 lb. is stated as the yield of ammonium sulfate per short ton of raw coal; this is less than the average production from any well operated byproduct coke-oven plant treating coal of the character usually coked in Pennsylvania and Ohio.

The statement as to the comparative yields of light oil is somewhat misleading in view of the results obtained during the past year or two by the more modern byproduct coke plants. The plants put in operation by the H. Koppers Co., during the past two years, are producing about 3.5 gal. of light oil per short ton of coal, and several of these plants are producing more than 4 gal. per ton. The yield of pure toluene runs from 0.45 gal. to 0.55 gal. per ton.

The quality of the light oil obtained from the Carbocoal process is of much greater importance than would be inferred by one not closely familiar with the subject. The presence of paraffins in the benzol and toluol fractions seriously detracts from their commercial value; the benzol and toluol fractions derived from the Carbocoal process contain about 50 per cent. of paraffins. It should be thoroughly understood what these paraffins are. They are simply hydrocarbons that go to make up ordinary petroleum, and if a successful method for the removal of paraffins from benzol and toluol has been developed, this can at once be applied to several well known processes by which benzol and toluol can be made directly from petroleum, which have as yet been total failures on account of the contamination of these products by paraffins.

It is very doubtful whether the method for conducting this operation, of which Mr. Malcolmson speaks, has been made commercially practicable. This separation of paraffins from benzol and toluol presents the utmost technical difficulties, and although a great number of investigators

* Chief Chemist, H. Koppers Co.

have worked on this subject, and although millions of dollars have been spent by various chemical and munition concerns in attempting to solve the problem, no successfully commercial process has yet been put into operation, and the great number of failures makes one skeptical as to any new and untried suggestion of this sort. The presence of paraffins in excess of a few per cent. in either benzol or toluol is fatal to the successful use of either of these materials in the manufacture of high explosives and other important chemicals for which they are so much in demand. The Government specifications for pure toluol stipulate that not more than 2 per cent. of paraffins shall be present. It is very important to keep the distinction between the light oil obtained by the Carbocoal process and that obtained from coke-oven gas well in mind. The former is of no value except as a source of motor fuel, while the latter is practically indispensable as a source of our most important high explosives.

Charles H. Smith,* New York, N. Y. (written discussion†).—I should like to clear up certain points raised by Mr. Sperr, as he has apparently misunderstood some of the comparisons made by Mr. Malcolmson between the Carbocoal process and that of the byproduct coke-oven industry, and more particularly his reference to our statement that the Carbocoal process produces "ammonia sulfate in excess to that normally recovered in the byproduct coke process."

Mr. Sperr calls attention to the fact that Table 3 of Mr. Malcolmson's paper states that 20,000 to 25,000 lb. of ammonium sulfate is recovered from the carbonization of 1000 tons of Clinchfield coal, and that later in the paper the statement is made that 21 lb. of sulfate of ammonia is recovered per ton of coal carbonized. In the first case, this paper is dealing specifically with the results from Clinchfield coal, and in the second case it is dealing with an average sample of high-volatile coal, running from, say, 33 to 35 per cent. volatile matter.

Mr. Sperr states that if this same coal were carbonized in a modern byproduct coke oven, the yield would be from 26 to 28 lb. of sulfate of ammonia. A modern byproduct coke oven, in first-class operating condition, might be made to yield the results outlined by Mr. Sperr. On the other hand, I have in my files the official report of a series of tests by the H. Koppers Co. on this same Clinchfield coal, under date of June 3, 1914, in which the practical yield on an 18-hr. coking time is given as follows: Ammonium sulfate, 20 lb.; coke, 69 per cent.; tar, 7,4 gal. The coke manufactured from this coal was soft and spongy in structure, and the H. Koppers Co. reported that in order to obtain a satisfactory metallurgical coke it would be necessary to admix approximately 25

* President, International Coal Products Corporation. Inventor of the Carbocoal process.

† Received Oct. 2, 1918.

per cent. of low-volatile coal. A further test was made on June 5, 1914, using 25 per cent. of Pocahontas and 75 per cent. of Clinchfield coal, from which the following practical yields were reported: Ammonium sulfate, 19 lb.; coke, 76 per cent.; tar, 5 gal.

The necessity of an admixture in order to obtain coke with a satisfactory structure is the point we particularly desire to emphasize in comparing the two processes, rather than a direct comparison of the results that could be obtained by carbonizing the same coal under the two methods. Modern byproduct coke practice is confined almost entirely to the carbonization of mixtures of coal, ranging from 26 to 31 per cent. in volatile, in order to get coke having a satisfactory structure. The average yield of sulfate of ammonia in carbonizing such mixtures will approximate 19 lb. per ton of coal carbonized. The Carbocoal process, on the other hand, is especially adapted to carbonizing coals of higher volatile content, and particularly those coals ranging from 33 to 38 per cent. in volatile, without the necessity of admixtures. This process, therefore, is utilizing a fuel that would naturally yield a considerably larger quantity of sulfate of ammonia and tar. The higher yields in the Carbocoal process, stated in the Malcolmson paper, are therefore to be expected, and it was not intended to make a comparison with what could be accomplished in byproduct coke ovens if the structure of the coke were disregarded and high-volatile coal were used for carbonization. This explanation may serve to clear up the point raised by Mr. Sperr.

In regard to the yields of light oil given in the paper, there was no intention to belittle in any way the results of the byproduct coke process. We have no doubt that the statement of Mr. Sperr in regard to the yield of light oil in some of the latest H. Koppers Co. plants is accurate. The figures given in the Malcolmson paper, however, do not go into the results obtained under the very best conditions in the Carbocoal process, but were intended to represent average conditions. In testing fuels in any carbonization process, the range of results varies considerably with different coals, and average results should be taken, rather than specific results obtained under the most favorable conditions. Certain coals tested in the Carbocoal process yielded as much as 5 gal. of light oil per ton of coal carbonized, from the primary distillation alone. The particular fuel in question was a cannel coal and could, therefore, not be considered a representative fuel.

In regard to the quality of the light oil obtained by the Carbocoal process, and the value of the tar oils in general, this is a matter which can only be definitely proved by experience in marketing Carbocoal oils on a large scale. If we estimate the average yield of light oil from byproduct coke ovens as 2½ gal. and of crude tar as 6½ gal., we would have the following market values under present conditions:

$2\frac{1}{2}$ gal. light oil at 50 c. per gal	1.25
$6\frac{1}{2}$ gal. of tar at 4 c. per gal	0.26
Total	\$1.51

The Carbocoal process will yield 20 gal. of tar distillates, with an average value of 24 c. per gallon, or a total value of \$4.80, and by referring to prices prevailing prior to the war it will be found that this type of oil never sold below 15 to 17 c. per gallon. The present market value of the two products can therefore be easily compared.

In regard to Mr. Sperr's assumption that benzol and toluol fractions derived from the process contain about 50 per cent. of paraffin, we think Mr. Sperr's assumption inaccurate. We permitted Mr. Sperr's representatives to make certain tests on a small apparatus, in order to confirm the statements made by us regarding the yields. These representatives informed us that the total yields obtained in these tests were greater than the average yields represented by us from the same coal. The apparatus used for these tests was not a commercial retort, and we have learned by experience that this laboratory apparatus yields a light oil containing approximately 30 to 50 per cent. of paraffins, as compared with 4 to 20 per cent. of paraffins in the light oil derived from the commercial retort. Coke-oven engineers will recognize that the quality of the results obtained from distilling coal in a metal retort, where the charge is limited to 30 lb., will be quite different from those obtained in a commercial retort operating with a capacity of 1 ton per hour, although we have found the quantity of byproducts obtained per ton to be practically the same. We might also note the particular object of the "cracking" referred to in the Malcolmson paper. By this method we have completely eliminated all the paraffins from our light oil, and by adding some of our higher-tar oil fractions we have obtained total yields of toluol per ton of coal several times the total yield per ton obtained in the coking process.

The present shortage of toluol and its high price will warrant such measures, but in peace times it is universally admitted that the light oil from both processes will be largely marketed as motor spirits, in which case the paraffin hydrocarbons present in these oils will not be objectionable, and on account of lower freezing points and ease of ignition may probably be beneficial.

In regard to the practicability of "cracking" petroleum oils and producing c.p. toluol therefrom, I might add that, notwithstanding the early failures of certain processes, this is now being done on a very large scale, and that the results therefrom, up to the present time, are entirely satisfactory.

In making a comparison of the two processes, we do not believe it was Mr. Malcolmson's intention to compare the financial benefits or the

economic status of the Carbocoal process with that of the established byproduct coke industry. The two processes represent different types of carbonization, yielding substantially different quantities and qualities of various products. The Carbocoal process yields a smokeless fuel of great density, available for many uses for which coke is not suitable, while coke, on the other hand, has well-established markets for metallurgical use. The byproduct coke process gives a substantial yield of surplus gas, and is therefore located near where the consumption of gas is great, where it will yield its greatest value. The Carbocoal process uses all of its gas in the distillation of the coal and in the refining of the oils. Carbocoal plants will therefore be located at the mines and the Carbocoal shipped to the consumer by direct route, requiring transportation facilities for only 72 per cent. of the raw coal. In the coking process, the entire coal required for distillation must be shipped to the ovens, usually located at a considerable distance from the mines, and the finished product, coke, representing 70 per cent. of the original coal, re-shipped to the consumer, requiring double transportation facilities. Byproduct coke ovens produce light oil and tar, while the Carbocoal process produces oil distillates. The sulfate of ammonia from the same coal would be approximately the same in both processes, but on account of the higher-volatile coal ordinarily used in the Carbocoal process, as compared with that utilized in the byproduct coke process, the yield is greater in the Carbocoal process.

The railroads have established coal rates for the movement of Carbocoal, on account of its density, as compared with coal. The rates on coke, on account of its lack of density, are approximately 15 to 20 per cent. higher than coal rates between the same points. This alone is of enormous economic benefit, as compared with coke used for fuel purposes.

The comparisons between the two processes are not made for competitive purposes, but to define clearly just what products are derived from the Carbocoal process as compared with the already well-known products from byproduct coke ovens, and their general suitability for market.

A. W. Calloway,* Washington, D. C. (written discussion†).—In a discussion of Mr. Malcolmson's paper which describes the method of coal distillation developed by Mr. C. H. Smith, attention is first directed to the fact that apparently Mr. Smith has accomplished by mechanical agitation what byproduct coke-oven builders have been working many years to accomplish by other means; namely, the complete distillation of coal in minimum length of time with a maximum of byproduct recovery. The coke-oven builders are not changing the fundamental

* Director of Bituminous Distribution, U. S. Fuel Administration; President, Davis Coal and Coke Co., and Pittsburg Terminal R. R. and Coal Co.

† Received Oct. 7, 1918.

design of their ovens, but are steadily making them narrower. Two benefits are derived from the narrower ovens; first, a low wall temperature, which increases the byproduct recovery, and second, a faster coking time.

In the usual byproduct coke oven, the coal charge is stationary, and the heat necessary for the distillation must be transmitted or conducted from the walls of the oven slowly through the charge, driving off the volatile matter and coking the charge from the sides to the center of the oven, the result being a comparatively slow distillation, with the temperature of the walls higher than necessary to coke the coal, because the heat has to be conducted through that part of the charge already coked; and while the charge in coking shrinks away from the walls there is a gap left which retards the transfer of heat from the walls and also allows the gases given off to pass up the sides of the hot wall, where some of the hydrocarbons are broken down, causing loss in byproduct recovery.

An interesting development in this connection is the discovery that with the narrow ovens and short coking time it is possible to coke coals that could not be satisfactorily coked in wide ovens; if it is granted that quick application of heat to coal increases its tendency to coke, then one would expect, in a mechanically agitated retort where all particles of coal in the charge come directly in contact with the hot walls, to find it possible to coke coals that could not be coked in the ordinary byproduct coke ovens. This is just what Mr. Smith has demonstrated can be done, in his primary retorts at his experimental plant at Irvington.

If the mechanical features of this operation have been successfully worked out at Irvington, as indicated in the paper, then Mr. Smith has indeed made a tremendous stride in the direction of utilizing large fields of bituminous coal throughout the country to the best advantage.

In the primary retorts in the Carbocoal process, where the charge of coal is in motion, and each particle of coal comes in contact with the heated wall of the retort, it is possible to operate with a much lower wall temperature, and the coking effect is obtained without the breaking down of the hydrocarbons to such an extent as they are broken down in the other byproduct coke ovens. This has long been recognized as the ideal condition for coal distillation, and if Mr. Smith has perfected the method we should then expect his results in the recovery of byproducts to show a very high production of tar and light oils, with probably a considerably reduced yield of gas. We would not expect a maximum yield of ammonia at this low temperature, but Mr. Smith in his secondary distillation appears to recover approximately as much ammonia as ordinarily is recovered in the byproduct coke oven distillation.

Tar.—Mr. Malcolmson has stated that a yield of approximately 30 gal. of tar per ton of coal is obtained in the combined primary and sec-

ondary distillations in the Carbocoal manufacture. Judged by the standards of the best practice in byproduct coke-oven work, this yield appears excessive, but with Mr. Smith's extremely low-temperature distillation I believe that such recovery may be obtained, although it is at the expense of a certain amount of gas. On account of its value, however, the increase in tar should offset the value of the gas that would be obtained from a higher-temperature distillation.

Sulfate of Ammonium.—Mr. Malcolmson claims a recovery of approximately 20 to 25 lb. of ammonium sulfate per ton of coal, depending upon the volatile matter of the coal. This compares favorably with byproduct coke-oven practice.

Light Oils.—Mr. Malcolmson reports light oil recovery of 2 to 3 gal. per ton of coal. This, I should say, is slightly below the best byproduct coke-oven practice on coals of the same volatile contents. It is my understanding, however, that his percentage of toluol in this light oil is high, as would have been expected from his low-temperature distillation.

Gas.—The production of gas is reported to be from 5000 to 6000 cu. ft. of very rich gas in the primary distillation, and 4000 cu. ft. of lean gas in the secondary distillation, making a total of 9000 to 10,000 cu. ft. of gas per ton of coal, the total heating value of which is about 85 per cent. of the heating value of the gas produced in the byproduct coke-oven operation, and, I should say, compares favorably, considering the low temperature of the primary distillation. Mr. Malcolmson states that at the present stage of development all of the gas recovered is required for the primary and secondary retorts; considering the low temperature required for the operation, and the fact that only 45 per cent. of the gas made in byproduct ovens is required for this operation, it appears to the writer that there is yet room for improvement, either in the design or construction of the retorts, whereby it should be possible to get better economy out of the gas used, and probably have surplus gas sufficient to furnish power for the plant and for the distillation of the pitch required for a binder in making the briquets.

Mr. Malcolmson called attention to the possibilities of the application of the Smith process in the production of a fuel suitable for use in the byproduct gas producers, in which the gas would be scrubbed and the ammonia extracted, his idea being to use the semi-Carbocoal; that is. the residue of the distillation in the primary retorts, and which contains considerable ammonia, for a fuel for byproduct gas producers in connection with steam plants. It is the writer's opinion that this might be practical, but better economy would be effected by the use of this fuel in byproduct gas producers furnishing gas for internal-combustion engines, in which a greater efficiency will be derived from the gas than if it were fired under boilers for steam generation.

Development of the Coke Industry in Colorado, Utah, and New Mexico

Discussion of the paper of F. C. Miller, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1307.

C. H. Gibbs,* Salt Lake City, Utah (written discussion†).—The development of the coke industry in Utah had a somewhat checkered career for the first 50 years of its existence. About 1851 the iron-ore deposits of the Iron Springs and Iron Mountain mining districts, Iron County, Utah, were discovered. Obtaining of iron for any purpose at the time involved its shipment from the Mississippi River to Utah, by ox-team. The result was that the pioneers endeavored to establish an iron-ore smelting plant at what was known as Iron City, near Iron Mountain, in Iron County. Bishop Taylor, who headed this enterprise, endeavored to obtain coal suitable for coking from the Cretaceous coal measures immediately east of Cedar City. A few small bee-hive coke ovens were built and lump coal was coked in these ovens; or, more properly speaking, the volatile matter of the lump coal was driven off, leaving a carbonized material that retained the lump shape, although it was extremely friable. This coke was promptly found to be unsuitable for iron smelting, not only due to its extreme weakness under smelting load, but also because of the fact that it carried about 5 per cent. sulfur. Bishop Taylor made a very thorough and exhaustive effort, covering a considerable period of years, to locate suitable coking coal in Southwestern Utah. His efforts failed, and in 1902 the iron-ore property acquired by him and associates was sold to the Colorado Fuel and Iron Co. It is of interest to note in this connection that the iron-ore deposits of Iron County at present are the largest known undeveloped iron-ore fields on the North American continent. It is safe to say that there is at least one hundred million tons of 55-per cent. ore actually in sight.

In 1878, coal-mining operations were begun at Connellsville, in Huntington Canyon, Emery County. Ten 8-ft. bee-hive ovens were constructed, and lump coal was carbonized for use in the Salt Lake valley smelters. The product was somewhat better than that obtained in Iron County, but was still of very inferior quality. It had to be hauled a distance of 140 miles by wagon to the two small smelters then operating in Salt Lake valley. These ovens operated only a very short time.

The next move toward obtaining a coking coal was in 1889 when the Pleasant Valley Coal Co. began operations in the Castle Gate district. In 1890, eighty 8-ft. bee-hive ovens were constructed, and the product was used until 1900 in all the smelters in Utah. During this period, 124 additional ovens were constructed, making a total of 204 bee-hive ovens operating at Castle Gate.

* Geologist, Utah Fuel Co.

† Received Sept. 14, 1918.

The Castle Valley coal field was thoroughly prospected during the '90's for a better quality of coking coal, and in 1898 natural coke was discovered at the present location of Sunnyside. This natural coke was formed by the burning and carbonizing of outcrop coal. Due to its hardness it was uncovered by weathering, which lead to prospecting and the opening of the Sunnyside mines.

The Sunnyside district carries the only genuine coking coal found in Utah. There are several areas in which semi-coking coal occurs, but none that in any way approaches the Sunnyside product either for strength, quality or low ash content. Mining operations were begun at Sunnyside in 1900, and the product was shipped to the ovens at Castle Gate. As soon as the Utah smelters obtained coke made from Sunnyside coal the smelting results were so much more satisfactory than those obtained from the Castle Gate product, that the Utah Fuel Co., as rapidly as possible, has increased the Sunnyside output to such an extent that it now takes care of the entire coke requirements of this territory.

The Sunnyside coal ranges in thickness from 5 to 14 ft.; it is hard and blocky; stands weathering well, and is the premier steam fuel coal of Utah. Very little of it, however, has been used for steaming purposes, due to the fact that the entire production of this district is used either for coke making or in byproduct gas plants located in Utah, Idaho, Montana, and Nevada. Throughout the coking area the coal shows evidence of considerable movement due to local bending, which is undoubtedly responsible for the fact that the Sunnyside district coal is of coking quality. Wherever the synclinal bending in the Sunnyside district ends, the coking quality of the coal practically disappears. In order to prepare the coal for coke ovens, the entire product is crushed so that it passes a ¼-in. screen. This crushing serves two purposes: first, that of producing a decidedly more uniform coke, and second, ringwall and breeze losses are materially reduced.

The following table gives the annual production of coke in Utah from 1890 to date:

Year	Tons	Year	Tons
1890	8,395	1904	156,337
1891	7,947	1905	220,706
1892	7,242	1906	259,924
1893	16,007	1907	317,925
1894	16,057	1908	180,074
1895	22,517	1909	184,745
1896	20,449	1910	150,677
1897	23,619	1911	174,000
1898	28,327	1912	302,457
1899	26,882	1913	332,396
1900	32,730	1914	349,898
1901	39,860	1915	301,420
1902	73,230	1916	424,828
1903	158,099	1917	374,775

As soon as the good quality of Sunnyside coke became generally known it was shipped not only to Utah, but north to Anaconda and East Helena, Montana; and to Nevada, Idaho, and parts of California.

In 1907 the Castle Gate bee-hive plant was abandoned, having been replaced by new ovens at Sunnyside. At present the Sunnyside coke-oven plant is the largest single bee-hive operation in the United States, consisting of 819 ovens of 12- and 13-ft. size. The coke produced carries a very low, uniform ash content, and is practically free from sulfur and phosphorus. Average analyses of this coal and of the coke made from it are as follows:

	Coal	Coke
Moisture	1.20	0.81
Volatile matter	39.13	0.83
Fixed carbon	53.69	87.36
Ash	5.98	11.00
	100.00	100.00

Sulfur in the coke will run from 0.7 to 1 per cent., and phosphorus from 0.03 to 0.05 per cent. An increasing tonnage of this coke is being used in Salt Lake valley and also on the West Coast, for steel making.

Low-temperature Distillation of Illinois and Indiana Coals

Discussion of the paper of G. W. Traer, presented at the Milwaukee meeting, October, 1918, and printed in *Bulletin* No. 141, September, 1918, pp. 1463 to 1470.

S. W. Parr,* Urbana, Ill. (written discussion†).—Multiplication of argument is unnecessary to establish the desirability of coking coals at low temperatures, that is to say, below 1200° F. The value of the semi-coke thus produced would doubtless go far toward solving the problem of smoke prevention, and suggests the possibility of the substitution of a smokeless fuel for anthracite and so-called smokeless coals. Whether such coke would have any value as metallurgical coke is a question which cannot be answered for lack of any experimental data in the use of such material. Of course interest is accentuated, at the present time, in the amount and character of the tars, which promise greatly to exceed in values the products obtainable from the high-temperature process.

The difficulties encountered in adapting the principles of low-temperature carbonization to industrial methods are well nigh insurmountable. Briefly stated, there is involved the heating of the center of a mass of non-conducting material by the external application of heat. It is a well established fact that the center of the mass of coal in a standard

* Professor of Applied Chemistry, University of Illinois.

† Received Sept. 23, 1918.

byproduct oven does not reach the stage of decomposition until after approximately 14 hr. have elapsed, the complete process requiring approximately 18 hr., and all this at a high temperature, approaching the limit of safety for the refractory material used in construction. Up to the present time, the common method of overcoming this difficulty has been by narrowing the cross-section of the retort; in Mr. Traer's experiments a width of from 4 to 8 in. has been adopted. This raises a serious question as to the possibility of economic operation under industrial conditions where the putting through of a large tonnage is essential.

However, the results as indicated in this paper are exceedingly valuable in that they constitute an additional verification of the character and value of all the byproducts obtained. I would call attention, however, to one seeming inconsistency in his discussion relating to the character of the tars. In the descriptive matter of the paper, the condensible products are referred to as light tars, for example, "the light tar produced by the low-temperature process is a liquid having the consistency of heavy cylinder oil," and again the yield of this material is referred to as "about 25 gal. of light tar and oil per ton of coal." The question might therefore be raised as to what is meant by "light tar." In the curve, Fig. 1, the yield of tar in gallons is directly proportional to the specific gravity, which would seem to indicate that the higher the yield of tar the heavier these condensible products. In our work the reverse is true; in general, the lower the temperature at which the decomposition is effected the lower the specific gravity and, in a general way, the higher the yield of tar. It is indeed quite possible to produce a tar, or rather an oil, under these conditions, which has a specific gravity slightly under 1. With an increase of temperature, on the other hand, by reason of a different type of decomposition, the tars have a specific gravity which may run as high as 1.2. It would seem, therefore, that Fig. 1 would more accurately indicate the results if the specific-gravity figures were reversed. At least, if the results were thus tabulated it would be more consistent with the values obtained in our own experiments.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the Milwaukee meeting, October, 1918, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Nov. 1, 1918. Any discussion offered thereafter should preferably be in the form of a new paper.

Pure Carbon-free Manganese and Manganese Copper

BY ARTHUR F. BRAID,* NEW YORK, N. Y.

(Milwaukee Meeting, October, 1918)

THE war has caused an increasing scarcity of phosphorus and its well known alloys with copper and tin. At the same time, the production of brass and bronze, nickel-silver, cupro-nickel, and other non-ferrous alloys, has considerably increased. The manufacturers of these products had therefore to secure other materials which would serve their purpose; principally that of a deoxidizer, which could be obtained promptly and regularly.

Fortunately these materials, pure carbon-free manganese metal and manganese-copper alloy, were not hard to find—in fact, they were never lost. Manganese in various forms has been used in Europe for more than a century; in this country, however, when manganese was first used, and indeed for a long time thereafter, it was consumed mainly in the manufacture of manganese-bronze. Many foundrymen at that time used manganese-copper with the same freedom as phosphor-copper. Although iron enters into the composition of certain grades of bronze, it is very detrimental to non-ferrous mixtures in general; consequently ferro-manganese is not applicable, and therefore pure manganese metal, or the alloy of manganese and copper, technically free from iron and other impurities, is now being generally used.

The following are the principal elements having an affinity for oxygen: 1, Sodium. 2, Potassium. 3, Calcium. 4, Strontium. 5, Barium. 6, Magnesium. 7, Aluminum, 8, Phosphorus. 9, Silicon. 10, Manganese. 11, Iron. 12, Zinc. 13, Lead. Each metal has its natural flux, or deoxidizer, in the form of a metal or non-metal which will alloy with it, and has a strong affinity for oxygen. For example, phosphorus, as is well known, acts very beneficially in copper alloys that contain tin.

Within the last few years, and particularly since the war began, the great value of manganese in nickel alloys has been demonstrated, and one by one the manufacturers of these products have adopted its use. While manganese has not so strong an affinity for oxygen as magnesium, aluminum, or silicon, it is nevertheless sufficiently powerful to reduce any oxide of nickel, copper, or zinc that may be present in the nickel alloy to be purified.

* Met. Engr., Metal and Thermit Corporation.

It is this "medium" affinity for oxygen that renders manganese valuable in casting nickel alloys for rolling or drawing purposes, since the oil, burning at the mouth of the mold, is capable of reducing the thin film of manganese oxide that forms upon the stream of metal as it is poured. Aluminum or silicon oxides are not reduced by burning oil, and, therefore, it frequently happens that castings are dirty when aluminum or silicon is used; with manganese, clean castings result if ordinary precautions are taken in pouring.

It is customary to add the manganese in the form of manganese-copper alloy (30 per cent. Mn and 70 per cent. Cu). The addition to nickel silver is about 3 or 4 oz. of the alloy per 100 lb. of the mixture (2 gm. per kilo), equivalent to about 0.06 to 0.075 per cent. manganese. In such alloys as cupro-nickel, the amount of manganese-copper should be almost doubled. This quantity introduces about 0.12 to 0.15 per cent. manganese, and to certain grades of nickel-copper, 0.25 per cent. manganese is added. The manganese-copper should be introduced into the mixture after all the other metals have been melted and the whole well stirred. The mixture should then be left for a few minutes so as to give the manganese time to act. It will be found that manganese gives excellent results in nickel alloys.

Another important feature in the use of manganese is its strong affinity for sulphur, exceeding that of all other metals; when introduced into a mixture containing sulphur, sulphide of manganese is formed at once, and rises as slag to the top of the metal. As sulphur is frequently present in cupro-nickel alloys, the advantage of this property of manganese is obvious. I believe that more attention should be given to sulphur in non-ferrous mixtures, particularly at the present time when raw materials and fuel are not generally of so high quality as before the war.

In the casting of brass, it has been shown that manganese acts best when there is a high proportion of zinc. On the other hand, in a red brass, phosphorus is used with excellent results because it causes the tin, with which it alloys more readily, to assume a crystalline structure and produces a more homogeneous casting. A number of concerns are experimenting with manganese, to take advantage of its hardening effect, and thus diminish the amount of tin used in certain mixtures.

The present tremendous increase in the use of manganese has been brought about to a great extent by the demand for munitions, etc., since, in addition to the various mixtures previously mentioned, manganese is used in nichrome, monel metal, aluminum, and stellite, the well known high-speed cutting tool, as well as in other less well known mixtures. Probably the most recent use for manganese is in a certain non-ferrous mixture which is used for the production of the necessary charcoal for gas masks by the carbonization of fruit stones.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS
[SUBJECT TO REVISION]

DISCUSSION OF THIS PAPER IS INVITED. It should preferably be presented in person at the New York meeting, February, 1919, when an abstract of the paper will be read. If this is impossible, then discussion in writing may be sent to the Editor, American Institute of Mining Engineers, 29 West 39th Street, New York, N. Y., for presentation by the Secretary or other representative of its author. Unless special arrangement is made, the discussion of this paper will close Apr. 1, 1919. Any discussion offered thereafter should preferably be in the form of a new paper.

A Metallographic Investigation of Transverse-fissure Rails with Special Reference to High-phosphorus Streaks

BY G. F. COMSTOCK,* A. B., MET. E., NIAGARA FALLS, N. Y.

(New York Meeting, February, 1919)

THE subject of transverse fissures in steel rails has been discussed very thoroughly in recent years from various points of view and the final opinions expressed may be roughly classified into two groups:

(1) That these fissures are the result merely of fatigue of the steel and are independent of the quality of the metal.

(2) That the quality of the metal and the mill practice must have something to do with them.

The first point of view was most ably and logically presented by J. E. Howard,[1] and in the discussion of this paper, as well as in several other preceding publications, Dr. P. H. Dudley, Consulting Engineer of the New York Central Lines, has strongly defended the other opinion.[2] The steel makers of the country have naturally rallied under Mr. Howard's banner, hoping to place the entire blame for these failures upon the railroads with their high wheel-loads, hard steel, heavy traffic, and sometimes inferior road-bed; while the railroad men, on the other hand, have been busy accumulating statistics and records in the effort to find an actual reason in the rails themselves that would account for the seemingly haphazard occurrence of transverse fissures under varying conditions and at widely separated points.

The view that these fissures were due merely to normal fatigue under alternating stresses seemed most reasonable to the writer until quite recently, because from work done in this laboratory, as well as the work of other investigators of the problem, no structural differences, in the vast majority of cases, were found between metal at the nuclei of transverse fissures and metal at similar positions in the same rails or in other rails that had not developed fissures. Within the last year or two, however, since the method of etching polished sections for the microscope with a cupric chloride solution has been tried systematically on lengthwise sections, passing through the nuclei of transverse fissures, evidence

* Metallographist, Titanium Alloy Manufacturing Co.

[1] *Bulletin* No. 131 (November, 1917) 1871. *Trans.* (1918) **58**, 597.

[2] *Bulletin* No. 136 (April, 1918) 777. *Trans.* (1918) **58**, 627.

began to accumulate that there was a certain structural peculiarity of the metal associated with these fissures, very often showing its most distinct development at the nucleus rather than elsewhere in the section examined. So far as the writer is aware, this particular method of examination has not been used by other workers who have published results of metallographic investigations of transverse-fissure rails, so that it may be of interest to present at this time the data that have been acquired through its use.

The cupric chloride reagent that the writer has found to give the clearest and most reliable result in etching polished steel sections for the microscope is the one recommended by Stead.[3] A slightly modified form of this reagent is described in another paper[4] by the same author on the same subject. As used by the writer, it was made by dissolving 2.5 gm. of cupric chloride and 10 gm. of magnesium chloride in 5 c.c. of hydrochloric acid and the smallest possible quantity of hot water, and diluting with alcohol to 250 c.c. Its action on a polished steel surface consists in depositing a film of copper quickly on normal metal, while metal higher in phosphorus remains bright for a longer time. Thus if the action is not continued too long, the location of high-phosphorus areas on a polished section can be shown very clearly as bright spots on a darker background. Silicon, chromium, nickel, copper, and other elements existing in solid solution in the steel, have effects similar to phosphorus under the action of this reagent, but in general it is phosphorus of which the effect is most important and most commonly encountered. The pattern developed by this etching may be made more contrasty by dissolving off the deposited copper with ammonia, as described by Charpy and Bonnerot.[5] This procedure was not followed by the writer in any of the work done on transverse-fissure rails, and the cupric chloride etching was always continued to the same point, as far as could be judged, so that a true comparison in contrasts between different samples was maintained. The effect of the cupric chloride etching on the samples considered in this paper was checked by repolishing and etching again with a 0.5-per cent. solution of picric acid in water, as advised by Stead.[4] This solution darkens the high-phosphorus areas, leaving normal metal brighter; but it was found not so easy to use as the alcoholic cupric chloride, and more apt to act irregularly and show peculiar curved markings that were not duplicated after repolishing and etching again.

Through the courtesy of Dr. P. H. Dudley, of the New York Central

---

[3] J. E. Stead: Iron, Carbon, and Phosphorus. *Jnl.* Iron and Steel Institute (No. I, 1915) **91**, 140.

[4] Iron, Carbon, and Phosphorus. Presented at a meeting of the Iron and Steel Institute, May 2–3, 1918. *Advance copy* No. 19.

[5] G. Charpy and S. Bonnerot: Note sur l'hétérogenéité des aciers. Comptes Rendus (Oct. 22, 1917) **165**, 536–540.

Lines, and a few others, many opportunities have been afforded this laboratory during the past 6 years for investigating the structures of rails that had failed from transverse fissures. At first, when the usual methods of examination were used, such as the making of sulphur prints, examining polished sections for non-metallic inclusions, and sections etched with picric acid or alkaline sodium picrate for the carbon distribution and microstructure, no structural differences were found, in the large majority of cases, between the metal at the nuclei of fissures and that at similar positions in the rail section where fissures had not developed. There were, of course, a few exceptions, where the origin of the fissure could be definitely traced to segregated streaks in the steel, such cases being generally among those in which the transverse fissure had developed from a longitudinal crack. The two sulphur prints shown in Fig. 1 and 2 are illustrations of the exceptional cases where the nuclei of transverse fissures were located directly in segregated streaks that caused dark spots on these prints.

Fig. 1. Fig. 2.

Fig. 1 and 2.—Sulphur prints, $\frac{7}{10}$ natural size, of rails that failed from transverse fissures, the arrows pointing to the location of the nucleus in the cross-section.

When the use of cupric chloride reagents was discovered and advocated by Stead and others for the detection of phosphorus segregation in steels, and this method began to be applied to longitudinal sections cut through the nuclei of transverse fissures in rails, it was found in many cases that the most distinct of the streaks shown in this way passed through the nucleus. In some of these rails the streaks were about the same throughout the section examined, but in practically none were they absent or even indistinct. Fig. 3 is a photograph, taken at a magnification of about $2\frac{1}{2}$ diameters, of two polished microscope specimens etched with the aqueous picric acid solution, which darkens the high-phosphorus streaks. The edges of these specimens show parts of trans-

verse fissures, with the polished sections cutting through the nuclei, and in each case it is plainly seen that the nucleus of the fissure is directly in line with the most distinct dark streak on the polished surface. Fig. 4, 5, 6, and 7 are photomicrographs of the polished surfaces of specimens cut, like those in Fig. 3, through the nuclei of transverse fissures in rails, but etched with cupric chloride. Each of these shows the edge of the specimen at the nucleus of the fissure, and the most distinct high-phosphorus streaks are shown in every case passing directly into these nuclei. Fig. 8 and 9 are similar photomicrographs of other rails that showed longitudinal cracks running through the streaks in line with the transverse fissures. Fig. 9 shows also a transverse crack which was about $\frac{5}{16}$ in. from the fissure, and in the same segregated streak as its nucleus.

Fig. 3.—Two polished specimens for the microscope etched with aqueous picric acid and magnified about $2\frac{1}{2}$ diameters, showing parts of transverse fissures on their edges and the most distinct streaks on the polished surfaces in line with the nuclei.

Having seen how high-phosphorus streaks were found associated with transverse fissures in all rails that failed in this way and that were examined with reference to such streaks, it would be of interest to look into their causes and determine whether they necessarily exist in all rails, or merely in rails subjected to certain conditions of manufacture. If a definite cause for the streaks can be established, and if some rails can be found without them, it should be easy to show definitely whether or not they really have any connection with the formation of transverse fissures.

The cause of the irregular effect of the cupric chloride and aqueous picric acid solutions on polished steel samples has been demonstrated by Stead, in the papers already mentioned, to be due to the irregular distribution, chiefly, of phosphorus, but partly of other elements in solid solution in the steel. By the well known process of selective freezing which steel ingots undergo after they are poured, the purer metal forms

solid dendrites or "pine-tree" crystals in the liquid metal, which then contains more than its share of the carbon, phosphorus, etc. On cooling further, the dendrites increase steadily in bulk, while the remaining liquid decreases and at the same time becomes more and more saturated with

FIG. 4 FIG. 5.

FIG. 6. FIG. 7.

FIG. 4, 5, 6 AND 7.—PHOTOMICROGRAPHS OF LONGITUDINAL SECTIONS OF RAILS AT THE NUCLEI OF TRANSVERSE FISSURES, ETCHED WITH CUPRIC CHLORIDE AND MAGNIFIED 16 DIAMETERS, SHOWING DISTINCT STREAKS AT THE NUCLEUS IN EVERY CASE.

impurities. Thus the ingot, when first frozen, is far from homogeneous, and can become so only by diffusion in the solid state. This takes place to some extent in the soaking pits, especially in regard to carbon, which becomes thoroughly diffused much sooner than phosphorus, according to Stead and other authorities. When the ingot is rolled out into a rail,

any irregularities in composition are of course rolled into streaks, and instead of a dendritic structure, the result is a lamination. Since the carbon usually becomes thoroughly diffused in the soaking pit, the laminations do not appear in the ferrite-pearlite structure, but since phosphorus diffuses very slowly the laminated structure may often be expected to show in the finished rail when treated in such a way as to reveal the distribution of this element.

Every ingot, when first cast, is chilled quickly on its outside by the cold mold with which it is in contact, and hence its outer skin is nearly homogeneous, and free from coarse dendrites, segregation, etc. For this

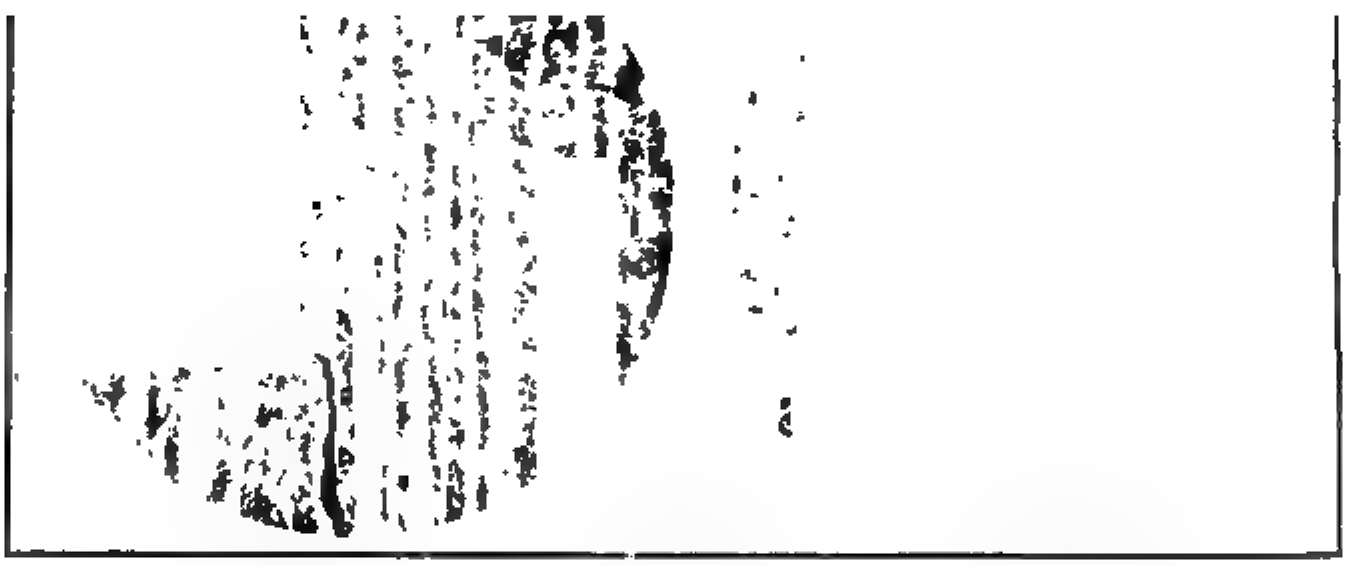


Fig. 8. Fig. 9.

Fig. 8.—A longitudinal crack connected with a transverse fissure in a specimen etched with cupric chloride and magnified 16 diameters.

Fig. 9.—A longitudinal and transverse crack in a segregated streak in which the nucleus of a transverse fissure was located; etched with cupric chloride and magnified 16 diameters.

reason, the outer surface of a steel rail is always free from high-phosphorus streaks to a greater or less depth. Transverse fissures generally have their nuclei a short distance inward from the surface of the rail section, and it has often been noted that the nucleus will occur at the same distance below the top of the head as the topmost distinct high-phosphorus streak. This streak would, of course, have been subjected to a greater bending moment in service than any streak existing nearer the center of the rail, and hence might be expected to crack first.

The cause of the high-phosphorus streaks has been seen to be selective freezing in the ingot, which cannot be avoided by any means now known. The effects of this selective freezing may, however, be remedied or overcome by diffusion in the solid state, which is a very slow process in regard to phosphorus. If longer heating of the solid steel in rail manufacture will decrease the intensity or distinctness of the high-phosphorus

streaks, by allowing more thorough diffusion, then rails rolled from reheated blooms should show these streaks less distinctly than rails rolled direct from ingots. A most interesting fact in this connection is that out of the few hundred rails that have failed from transverse fissures on the New York Central Lines, just two of them had been rolled from reheated blooms. If it could be shown, therefore, that rails rolled from reheated blooms had the high-phosphorus streaks less in evidence than direct-rolled rails, a strong support would be secured for the theory that these streaks had some influence on the origin of the fissures.

To investigate this point, 24 samples of rails were secured through the kind coöperation of Dr. Dudley, of the New York Central Lines, 12 of which had failed from transverse fissures, while the rest had given good service in track. All but one of the former had been rolled direct from ingots, and all but two of the latter had been rolled from reheated blooms. Twelve samples of rails that had failed from transverse fissures, and that had been previously received from Dr. Dudley, the Louisville & Nashville Railroad, and R. W. Hunt & Co., were also taken into this investigation, making 24 transverse-fissure rails and 12 good service rails. Data received from the senders regarding these samples are shown in Table 1. Unfortunately data as to the amount and character of service endured by the various samples are not at hand, and the method of rolling of the first six samples is not positively known, although there is little doubt that all were rolled direct. These samples represent different heats of steel, with the following exceptions: No. 5 belonged to the same heat as No. 2; No. 7 and 8 were both from another heat; No. 11 and 12 likewise; and also No. 33 and 35. Since the unit for this work seems properly taken as the ingot, with its particular time of heating, it did not appear necessary that each sample should represent a separate furnace charge, even though the results were to be finally averaged for each class of steel. The samples of failed rails represented heats that had produced anywhere from 1 to 10 transverse-fissure rails; No. 21 was one of the two rails rolled from reheated blooms that have been found, on the New York Central Lines, to have failed in this way.

Table 2 gives the results of the metallographic examination of these samples. The first thing done to each was the making of sulphur prints from a cross-section generally within an inch or two of the transverse fissure, provided it appeared on the sample received. These prints were classified as good, fair, poor, or bad, according to the amount of segregation shown. Fig. 1, mentioned above, shows a print from sample 9, classed as "poor," while Fig. 2 shows one from sample 14, classed as "fair." Those classed as "good" showed less segregation than the latter, and those classed as "bad" showed more than the former.

Sections for microscopic examination were cut from the heads of all the samples, longitudinally and upright, that is, parallel to the plane of the

web. The sections covered from ½ to ¾ in. of the height of each head, and were so located as to cut through the nucleus of the fissure in samples that showed transverse fissures. In those that did not, the sections for the microscope were cut near the center of the head. From some of the samples several sections were examined. The grading with respect to presence of alumina, slag inclusions, and distribution of sulphides, was done by the writer from examination of the carefully polished sections before etching, the terms used being descriptive of the quality of the steel

TABLE 1.—*Description of Samples*

Sample No.	Mill	Lb. per yd.	Rail Letter	Method of Rolling	Service in Track
1	A	80	...	Probably direct from ingot.	Failed, transverse fissure.
2	A	90	F	Probably direct from ingot.	Failed, transverse fissure.
3	C	85	...	Probably direct from ingot.	Failed, transverse fissure.
4	A	80	...	Probably direct from ingot.	Failed, transverse fissure.
5	A	90	F	Probably direct from ingot.	Failed, transverse fissure.
6	A	80	...	Probably direct from ingot.	Failed, transverse fissure.
7	B	100	A	Direct from ingot.	Failed, transverse fissure.
8	B	100	A	Direct from ingot.	Failed, transverse fissure.
9	C	105	A	Direct from ingot.	Failed, transverse fissure.
10	C	105	D	Direct from ingot.	Failed, transverse fissure.
11	C	105	A	Direct from ingot.	Failed, transverse fissure.
12	C	105	A	Direct from ingot.	Failed, transverse fissure.
13	C	100	E	Direct from ingot.	Failed, transverse fissure.
14	B	100	A	Direct from ingot.	Failed, transverse fissure.
15	C	100	C	Direct from ingot.	Failed, transverse fissure.
16	B	105	C	Direct from ingot.	Failed, transverse fissure.
17	B	80	C	Direct from ingot.	Failed, transverse fissure.
18	C	100	E	Direct from ingot.	Failed, transverse fissure.
19	B	80	E	Direct from ingot.	Failed, transverse fissure.
20	C	100	B	Direct from ingot.	Failed, transverse fissure.
21	C	105	D	Reheated bloom.	Failed, transverse fissure.
22	B	100	B	Direct from ingot.	Failed, transverse fissure.
23	C	100	B	Direct from ingot.	Failed, transverse fissure.
24	B	80	C	Direct from ingot.	Failed, transverse fissure.
25	D	100	B	Reheated bloom.	Good service.
26	C	105	D	Reheated bloom.	Good service.
27	C	105	B	Reheated bloom.	Good service.
28	E	100	...	Reheated bloom.	Good service.
29	E	100	...	Reheated bloom.	Good service.
30	E	100	...	Reheated bloom.	Good service.
31	B	100	C	Direct from ingot.	Good service.
32	B	100	B	Direct from ingot.	Good service.
33	D	100	...	Reheated bloom.	Good service.
34	C	105	C	Reheated bloom.	Good service.
35	D	100	E	Reheated bloom.	Good service.
36	D	100	C	Reheated bloom.	Good service.

TABLE 2.—*Results of Examination of Samples*

Sample No.	Quality in regard to				Amount of free		Quality in regard to streaks shown by etching with	
	Sulphur print	Presence of alumina	Presence of slag	Distribution of sulphides by microscope	Ferrite	Cementite	Cupric chloride	Aqueous picric acid
1	Good	Poor	Good	Fair	Little	None	Bad	Poor
2	Good	Bad	Good	Fair	Traces	None	Bad	Bad
3	Good	Poor	Fair	Good	None	None	Poor	Bad
4	Fair	Good	Bad	Good	Little	One streak	Bad	Bad
5	Fair	Bad	Good	Fair	Little	None	Bad	Poor
6	Poor	Bad	Good	Poor	Traces	Considerable	Poor	Poor
7	Fair	Good	Good	Fair	Traces	None	Fair	Poor
8	Fair	Good	Good	Poor	None	None	Poor	Poor
9	Poor	Good	Fair	Poor	None	One streak	Bad	Bad
10	Good	Good	Good	Fair	None	None	Poor	Fair
11	Good	Good	Good	Poor	None	None	Bad	Bad
12	Good	Good	Poor	Good	Traces	None	Bad	Bad
13	Good	Poor	Good	Poor	None	None	Bad	Bad
14	Fair	Good	Good	Fair	Traces	None	Bad	Poor
15	Good	Good	Poor	Fair	None	None	Bad	Bad
16	Good	Good	Poor	Fair	Little	None	Bad	Poor
17	Good	Good	Good	Fair	Traces	None	Poor	Poor
18	Good	Poor	Good	Good	Little	None	Bad	Bad
19	Good	Good	Good	Fair	Little	None	Poor	Fair
20	Fair	Good	Good	Good	None	One streak	Fair	Fair
21	Good	Good	Good	Fair	None	None	Good	Good
22	Good	Good	Good	Fair	Traces	None	Bad	Bad
23	Good	Good	Good	Poor	Traces	None	Bad	Bad
24	Good	Poor	Good	Poor	Traces	None	Poor	Poor
25	Good	Good	Good	Fair	Traces	None	Good	Fair
26	Good	Good	Good	Fair	Traces	None	Fair	Fair
27	Good	Good	Good	Fair	Traces	None	Good	Good
28	Poor	Good	Good	Fair	Traces	None	Poor	Fair
29	Bad	Good	Good	Poor	Little	None	Bad	Bad
30	Fair	Good	Good	Poor	Traces	None	Fair	Poor
31	Good	Good	Poor	Poor	Much	None	Bad	Bad
32	Good	Good	Good	Poor	Much	None	Bad	Bad
33	Good	Good	Poor	Good	Little	None	Fair	Good
34	Poor	Poor	Good	Good	Little	None	Good	Good
35	Good	Good	Good	Fair	Traces	None	Poor	Bad
36	Fair	Good	Good	Good	Traces	None	Good	Fair

judged solely on the basis of the particular kind of inclusion under consideration. The data given in the columns headed "Amount of free ferrite" and "Cementite" were obtained by examination of the sections after etching with the usual alcoholic solution of picric acid; and in cases

FIG. 10.—GOOD. FIG. 11.—FAIR.

FIG. 12.—POOR. FIG. 13.—BAD.

FIG. 10, 11, 12 AND 13.—PHOTOMICROGRAPHS OF LONGITUDINAL SECTIONS OF RAIL HEADS ETCHED WITH CUPRIC CHLORIDE AND MAGNIFIED 16 DIAMETERS, TO ILLUSTRATE THE SIGNIFICANCE OF THE TERMS USED TO DESCRIBE THE QUALITY OF SPECIMENS WITH REGARD TO HIGH-PHOSPHORUS STREAKS, SHOWN BRIGHT BY THIS ETCHING.

where cementite was present this was checked by repolishing and etching with boiling alkaline sodium picrate. The term "one streak" in this connection does not mean that only one particle of free cementite was seen in the section, but that there was in the sample one segregated

streak containing an appreciable network of free cementite between the pearlite grains.

The samples were next repolished and etched with Stead's cupric chloride reagent, all as nearly as possible to the same degree, and were

FIG. 14.—GOOD. FIG. 15.—FAIR.

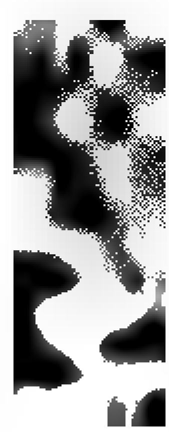


FIG. 16.—POOR. FIG. 17.—BAD.

FIG. 14, 15, 16 AND 17.—PHOTOMICROGRAPHS OF LONGITUDINAL SECTIONS OF RAIL HEADS ETCHED WITH AQUEOUS PICRIC ACID AND MAGNIFIED 16 DIAMETERS, TO ILLUSTRATE THE SIGNIFICANCE OF THE TERMS USED TO DESCRIBE THE QUALITY OF SPECIMENS WITH REGARD TO HIGH-PHOSPHORUS STREAKS, SHOWN DARK BY THIS ETCHING.

classified in the same way as the sulphur prints, according to the quality of the metal judged from the distinctness of the streaks shown. Fig. 10, 11, 12, and 13 illustrate the terms used in describing the quality after this etching. Finally the samples were all repolished again and etched

for 15 to 20 sec. with the aqueous picric acid solution recommended by Stead, and graded as before. Fig. 14, 15, 16 and 17 illustrate the significance of the terms for this grading.

TABLE 3.—*Classification of Samples*

In regard to	Grade	Transverse-fissure rails, per cent.	Rails that gave good service, per cent.	Rolled direct from ingot, per cent.	Rolled from reheated blooms, per cent.
Sulphur print	Good	67	58		
	Fair	25	17		
	Poor	8	17		
	Bad	..	8		
Presence of alumina	Good	67	92		
	Poor	21	8		
	Bad	12			
Presence of slag	Good	75	83		
	Fair	8			
	Poor	13	7		
	Bad	4			
Distribution of sulphides by microscope	Good	21	25		
	Fair	50	42		
	Poor	29	33		
Amount of free ferrite	None	38			
	Traces	37	58		
	Little	25	25		
	Much	..	17		
Amount of free cementite	None	83	100		
	One streak	13			
	Considerable	4			
Cupric chloride etching	Good	4	33	..	46
	Fair	8	25	11	27
	Poor	29	17	26	18
	Bad	59	25	63	9
Aqueous picric acid etching	Good	4	25	..	36
	Fair	12	33	16	36
	Poor	38	9	32	10
	Bad	46	33	52	18

In Table 3 these results are all averaged for the rails that failed from transverse fissures and for those that endured good service without failure, in order to get the average classification of each kind of rails with respect to the different characteristics that were examined. For instance, in regard to sulphur prints, out of 24 transverse-fissure rails, 16 were classed as "good" in this respect, or 67 per cent.; 6 were classed as "fair," or 25 per cent.; and the remainder, or 8 per cent., as "poor." The classification of direct-rolled rails was practically the same as that for the transverse-fissure rails, and the rails rolled from reheated blooms were also

similar to the good-service rails, so that it did not seem desirable to fill out the last two columns of the table except in regard to the high-phosphorus streaks.

In Table 3 it is readily seen that the majority of both the failed and the good rails were classed as "good" in regard to sulphur prints, presence of alumina, and presence of slag; and as "fair" in regard to distribution of sulphides, with either no ferrite or only traces, and with practically no cementite. Of course there are slight differences in these respects, and the failed rails are seen to average better in regard to sulphur prints, worse in regard to alumina and slag inclusions, and to have, on the average, less ferrite and more cementite than the good rails. The showing in regard to sulphur prints should not be taken to mean that rails showing segregation in these prints are more apt to give good service, without failure, than rails of which the sulphur prints are good, for this investigation is concerned with only one particular type of rail failure, and there is no question whatever about segregated rails being especially susceptible to another type of failure known as a "split head." These results show, however, that segregated sulphides are not a cause of transverse fissures. In regard to alumina inclusions, the results might be considered as indicating that these have some effect on the fissures were it not for the fact that no case has arisen where a streak of alumina particles was found in line with and close to the nucleus of a fissure. The showing in regard to free ferrite and cementite is merely a corroboration of the fact several times stated by other writers that transverse fissures occur most frequently in hard high-carbon rails. The indication is worth noting, however, that a thick ferrite network in the microstructure seems to mean less tendency toward the formation of fissures, while cementite-bearing streaks in the head mean a greater tendency toward their development.

The various aspects of the structure so far considered in Table 3 have given, for the two kinds of rails, classifications that were similar in their general indications, showing that none of these peculiarities could be an important cause of transverse fissures. The last two criteria, however, show a decided difference in the classification figures for the two kinds of rails, and indicate that there is here at least some relation between these aspects of the structure and the formation of the fissures. Thus, while 88 per cent. of the failed rails were classed as poor or bad in regard to the high-phosphorus streaks shown by the cupric chloride etching, only 42 per cent. of the good-service rails were so classed; and the aqueous picric acid etching checks these figures in almost the same way. Comparing the direct-rolled rails with the rails rolled from reheated blooms, the figures are more strongly suggestive, becoming 89 and 88 per cent., respectively, for the sum of the poor and bad classes of the direct-rolled rails after the two methods of etching, and only 27 and 28 per cent. for

the same classes of the rails rolled from reheated blooms. In obtaining these average classification figures for direct-rolled rails, samples 1 to 6, inclusive, had to be omitted on account of the slight uncertainty regarding their method of rolling. But on the 30 samples of which the method of rolling is known without doubt, the cupric chloride etching shows regularly increasing percentages from the "good" to the "bad" classes for the direct-rolled rails, while the percentages regularly decrease from "good" to "bad" for the rails rolled from reheated blooms. The aqueous picric acid etching checks these figures fairly closely. Here is, then, a clear indication that reheating the blooms in rail manufacture will give a product decidedly more free from high-phosphorus streaks than the direct-rolling process will give, and it has also been shown that rails can be made, and are made, that are practically free from these streaks (see Fig. 10 and 14).

The inclusion of samples 1 to 6 among the direct-rolled rails, where they belong in all probability, would alter the figures in the third column of Table 3 to only a slight extent. The difference between the classification in the first two columns of this Table and that in the last two columns is due, as shown in Table 1, largely to three samples—No. 21, 31, and 32. The former, as stated before, is one of the two rails that were rolled from reheated blooms that have failed from transverse fissures on the New York Central Lines, and hence is an exceptional case. The other two, both from the same mill, were rolled direct from the ingots, and showed very distinct high-phosphorus streaks, yet gave good service without developing fissures. As seen in Table 2, these two rails are the only ones in the entire series that showed much ferrite in their microstructures, and indeed they had every appearance of being Bessemer steel, although reported as open-hearth. It may be, therefore, that the presence of the thick ferrite network helped these rails to resist the development of fissures in spite of their high-phosphorus streaks, and this may likewise be the reason why Bessemer rails, in general, do not develop transverse fissures in spite of the streaks which would be expected from their higher phosphorus content. If these two rails were considered as exceptional, on account of being lower in carbon than all the other rails, and were discarded from the averages, together with the exceptional No. 21, the classification figures in Table 3 for the rails that gave good service would become practically identical with those for the rails rolled from reheated blooms, which offer a more striking comparison with the figures for the failed rails.

Attention should also be drawn to the three samples 28, 29 and 30, which were the only rails rolled by mill "E," and were received from a certain railroad where the service may not have been as severe as that which some of the other rails endured. These rails were the worst of all in regard to sulphur prints, and also made a poor showing in regard to high-phosphorus streaks, although reported as having been rolled

from reheated blooms. There is thus a suspicion that the mill practice was not the best where these rails were made, and that their service record might not have been so good had they been on the same lines as the other samples here considered. These rails were included among the averages in the "good service" and "reheated bloom" columns of Table 3, but had they been omitted on account of being from a different mill and railroad from the other samples, the showing in these columns would have been better.

Summarizing the evidence connecting transverse fissures with the high-phosphorus streaks shown by etching longitudinal sections of the rails with a cupric-chloride reagent, it has been shown that in many instances the nucleus of the fissure is located in the most distinct of the streaks in the rail head, or in the uppermost of the distinct streaks, and that practically all rails with this type of failure that have been examined have been found to contain these streaks. Also, it has been shown that of the rails examined, those rolled from reheated blooms were much less apt to contain these streaks, due to uneven phosphorus distribution, than the direct-rolled rails were, and many that gave good service in track, without failure, lacked the streaks entirely. This fact fits in very well with the discovery of Dr. P. H. Dudley, of the New York Central Lines, that rails rolled from reheated blooms do not, with two exceptions to date, develop transverse fissures, and the natural inference is that it is because they do not contain the high-phosphorus streaks. This gives a definite reason both from practice and theory for reheating the blooms in rail manufacture.

It is interesting to note also in this connection that W. R. Shimer[6] concluded that rails rolled from reheated blooms are more ductile than direct-rolled rails, regardless of their finishing temperature. He explained this by referring to the removal of rolling strains in the reheating furnace, an explanation which was not considered valid by Prof. Hoyt in discussing the paper. Probably a better diffusion of phosphorus was the chief reason for the better ductility found by Mr. Shimer in his rails rolled from reheated blooms, and this aspect of the microstructure was not mentioned either in his paper or in the discussion.

It should be understood that the high-phosphorus streaks need not be always present in direct-rolled rails, because if the ingot was kept in the soaking pit long enough the phosphorus would diffuse there just as well as in the reheating furnace for blooms, although it would probably take longer for thorough diffusion to occur in an ingot than in a bloom. Furthermore, a rail rolled from a reheated bloom might readily show distinct streaks if both the ingot and bloom had been heated only as short

[6] Effect of Finishing Temperature of Rails on their Physical Properties and Microstructure. *Trans.* (1915) **51,** 828.

a time as possible. Nevertheless, the chances for a direct-rolled rail to show a distinctly streaked condition in regard to phosphorus are much greater than in the case of rails rolled from reheated blooms, as is shown by this investigation.

It is not claimed that reheating the blooms is a sure cure and the only cure for transverse fissures in rails, because the presence of a fissure in sample 21 would refute this claim. But the evidence here given supports strongly the contention that segregation of phosphorus in abrupt alternate bands of almost microscopic size, running lengthwise in the rail head, are an important cause of transverse fissures, and that by reheating the blooms from which rails are rolled these bands may be reduced in intensity by diffusion and the tendency toward the formation of transverse fissures may be appreciably lessened.

These conclusions do not contradict or disprove the fatigue-failure theory of transverse fissures, although they seem to support the opposite view of origin from a defect in the steel. Mr. Howard's work has been valuable in showing how the peculiar appearance of these fissures is caused and in giving a reason for their failure to start at the upper surface of the rail. But may not these views of his be accepted, without denying the view of the other school that there must be some reason in the steel for the appearance of these failures in much greater numbers in rails from certain heats, or in rails from certain periods of rolling, than in other similar rails subjected to exactly the same service? The point missed by the supporters of the fatigue-failure theory is that even a fatigue failure must have a starting point, and that it is very reasonable to suppose that all possible variations in structure would not have exactly the same influence on the facility with which such a fatigue failure would start. It is claimed that transverse fissures can be produced mechanically at will at any point desired in any rail, which is interesting as showing that the mechanism of growth of these failures is now well understood. But almost any type of failure can also be produced at will, mechanically, at any definite point, and the important factor is to know what internal conditions in the material tested make the failure start more easily, and what conditions make it start with more difficulty or only after a longer time. This paper is presented with the idea of throwing a little light in a new direction on the internal conditions that help the beginning of transverse fissures in rails, and in the hope that it will be of some use in linking together the two opposing views as to the origin and growth of these peculiar failures.

INDUSTRIAL SECTION

This department is devoted to material concerning the products or operations of manufacturers, which, in the estimation of the Editor, is of news value to the mining and metallurgical field, but does not come within the scope of the main editorial section of the Bulletin.

Manufacturers are invited to submit to the Editor items descriptive of new equipment or processes, large or significant installations, and similar material of news character. If found available, items thus furnished will be published in this section without charge, subject to such editorial revision and condensation as may be necessary.

In cases where illustrations are required, cuts of the proper size should accompany the text matter.

JEFFREY PIT-CAR LOADER

In these days of rising wages and diminishing labor supply, any mechanical devices that will reduce the expenditure of muscular effort and promote output deserve recommendation. The Jeffrey pit-car loader, described in Bulletin No. 246, of the Jeffrey Manufacturing Co., Columbus, O., is of this class, as it facilitates what is usually one of the most arduous as well as the least efficient operations connected with mining. The appliance does not seem to be restricted to collieries, but should be equally useful in any metal mine dealing with flat ore-bodies, or operating a stoping system having flat floors.

As applied to coal mining, the advantage of the loader is not confined to the reducing of fatigue and expediting the loading of the individual cars, but its use entails sundry other efficiencies relating to the operation as a whole. Thus, if, with the loader, two men at a face can fill a car in half the time usually required, this face can be undercut, broken down, and loaded out twice as often in a given time, thereby maintaining a given desired daily output with half as many men, working in a territory only half as large. This means less development, haulage, and supervision.

TRADE CATALOGS

(Under this heading will be listed such catalogs or other advertising literature as may be received during the preceding month. Contributors should address their material to Engineering Societies' Library, 29 West 39th St., New York.)

BIGELOW Co. New Haven, Conn. Catalog describing the Bigelow Hornsby Water-tube Boiler.

BURT MANUFACTURING Co. Akron, Ohio. General catalog on oil filters, exhaust heads, and ventilators. 1917. Blue-print of Burt Unit-type Filter. 1914.

DEFENDER AUTOMATIC REGULATOR Co. St. Louis, Mo. Catalog No. 10.

E. I. DU PONT DE NEMOURS & Co. Wilmington, Del. Blasters' Handbook.

1918. REYNOLDS ELECTRIC Co. Chicago, Ill.

—— Bulletin 22. RECO color hoods. June 15, 1915.

—— 27. RECO Flashers. July 1, 1915.

—— 33. RECO Flashers. Dec. 1, 1915.

—— 202. Type "A" Alternating-current motors.

UNITED FILTERS CORPORATION. Brooklyn, N. Y. Sweetland's patent metallic filter cloth.

THE MINING AND METALLURGICAL INDEX

September, 1918

The Engineering Societies Library is prepared to supply the original, or a copy, translation, or abstract of any paper mentioned in the following index, at the following rates:

Translations, per 1000 words: German or French, $3.50; other languages, $4.50 and upward, by arrangement.
Copies of articles, maps, drawings, etc.
Photoprints, 10 by 14 in., per sheet............................ $0.25
Typewritten, per 1000 words............................ 1.00
Bibliographic searching, abstracting, etc., per hour.................... $1.50
Original article, publisher's price, plus postage. Orders for periodicals will be forwarded to the publishers, and bill will be mailed from the Library.
Address communications relating to the Index to Engineering Societies Library, 29 West 39th Street, New York.
In the following Index, volume numbers are given in heavy-faced figures, page numbers in light-faced figures.

MINERAL RESOURCES

(See also Mining Geology and Mining Practice)

ALUMINIUM (bauxite) deposits and the production of aluminium. *Engng.* (Aug. 16, 1918) **106**, 163–5. Serial; (Aug. 23, 1918) **106**, 191–3; (Aug. 30, 1918) **106**, 218–20. Conclusion.

ASPHALT in Abruzzo. D. O. Gigli, Asfalto dell Abruzzo. *Rassegnia Mineraria* (July, 1918) **48**, 117–20.

AUSTRALIA, Ore deposits of. *Indust. Austral.* (Aug. 1, 1918) **60**, 179.

BRITISH COLUMBIA in 1917. *Min. Jnl.* (Sept. 7, 1918) **122**, 521–2.

BURMA, Material resources. H. Adamson, *Bull.* Imp. Inst. Lond. (Jan.–Mar., 1918) **16**, 40–79.

CHINA, Mineral enterprise in. *Min. Mag.* (Aug., 1918) **19**, 59–61. Review.

CHROMITE. J. C. Williams, Colo. Sch. Mines *Mag.* (Sept., 1918) **8**, 157–9. *Min. & Sci. Pr.* (Aug. 31, 1918) **117**, 281–2. Abstract from Cir. issued by Colo. Sch. Mines.

COAL conservation committee, report. *Engr.* [London] (Aug. 23, 1918) **126**, 158.

COKING coal in Scotland, occurrence, discussion on Mr. R. W. Dron's paper, *Trans.* Min. Inst. of Scotland (Apr. 6, 1918) **40**, 111–5. From *Trans.* Inst. Min. Engrs.

COLORADO, Mining in 1918. *Engng. & Min. Jnl.* (Aug. 31, 1918) **106**, 381.

COPPER in the Americas. *Bull.* Pan American Union (July, 1918) **47**, 28–51.

DIAMONDS, discovery in South Africa. E. J. Dunn, *Indust. Austral.* (July 18, 1918) **60**, 91 *et seq.*

FERROALLOYS, Minerals for. *Iron Age* (Sept. 12, 1918) **102**, 671.

GERMANY and the French ore deposits. *Sci. Am.* (Sept. 28, 1918) **119**, 246.

GERMANY still covets French iron mines. *Iron Tr. Rev.* (Sept. 12, 1918) **63**, 612–3.

GOLD, Crisis in, mining. *Min. & Oil Bull.* (Aug., 1918) **4**, 363–4.

GOLD, Does the government want. *Min. Jnl.* (Aug. 10, 1918) **122**, 470–1.

GOLD, future production and necessity for proper stimulation. C. C. Jones, *Min. & Oil Bull.* (Aug., 1918) **4**, 367–8, 387.

GOLD, Price of, and the low grade mines. *South Afr. Min. Jnl.* (July 6, 1918) **27**, 219.

GOLD producers' harvest will come when the war ends. *Min. & Sci. Pr.* (Aug. 31, 1918) **117**, 279–80.

GOLD output: A suggestion. F. N. Fletcher, *Min. & Sci. Pr.* (Sept. 14, 1918) **117**, 344. Letter.

GOLD mining, How to aid. T. Marshall. *Min. & Sci. Pr.* (Sept. 14, 1918) **117**, 344–5. Letter.

GOLD and silver output, Future. M. T. Chestnut, Jr., *Min. & Sci. Pr.* (Sept. 7, 1918) **117**, 309–10. Letter.

GOLD Conference at Spokane. C. De Kalb, *Min. & Sci. Pr.* (Sept. 14, 1918) **117**, 341–2; 339, Editorial.

GOLD an essential or a non-essential? R. H. Tingley. *Am. Industries* (Sept., 1918) **19**, 19.

GOLD, dearer. A. Lesseurre, L'or plus cher. *Métaux All. Mach.* (July, 1918) 14–6.

MINING GEOLOGY AND MINING PRACTICE

(See also Mineral Resources)

ORE-DRESSING AND PREPARATION OF COAL

COLONIAL STEEL CO.

RED STAR BRAND

Hollow Drill Steel

RED STAR is a tough, strong, good cutting drill steel, free from interior defects.

The hole is regular and uniform in size and shape and of the same diameter throughout.

STANDARD STOCK SIZES

Round, 1, 1⅛ and 1¼; length, 15 to 18 ft.
Hexagon, ⅞, 1, 1⅛ and 1¼; length, 15 to 18 ft.

COLONIAL STEEL CO.

PITTSBURGH, PA.

Sales Offices: Boston, Mass., New York, N. Y., Chicago, Ill., St. Louis, Mo., Denver, Col., Salt Lake City, Utah.

COAL AND COKE

PETROLEUM AND GAS

METALLURGY OF IRON AND STEEL

(See also Ore-dressing and Preparation of Coal, Coal and Coke, Metallurgy of Non-ferrous Metals)

ELECTRIC furnaces. B. E. D. Kilburn, British Pat. 116853. *Ill. Off. Jnl.* (Aug. 14, 1918) 1762.

ELECTRIC furnace steel, Blowing air into. C. M. Carmichael, *Iron Tr. Rev.* (Sept. 26, 1918) 726.

ELECTRIC heating and tempering, Method of and apparatus for. H. P. MacDonald, U. S. Pat. 1274919. *Off. Gaz.* (Aug. 6, 1918) **253**, 164-5.

ELECTRIC steel making, triplex process. *Iron & Coal Tr. Rev.* (Aug. 9, 1918) **97**, 149.

ELECTRIC developments, Future, in Italy. *Iron & Coal Tr. Rev.* (Aug. 9, 1918) **97**, 151.

ELECTRIC metallurgical furnaces. *Engng.* (Aug. 2, 1918) **106**, 110–2. Serial.

ELECTRIC steel development. D. F. Campbell, *Iron Age* (Sept. 19, 1918) **102**, 685. From *Iron & Coal Tr. Rev.*

ELECTRIC steel production for small units. A. V. Farr, *Blast Fur. & Steel Plant* (Sept., 1918) **6**, 381–3. Paper read before Am. Drop Forge Assoc.

ELECTRIC welder. C. H. Thornblade, Canad. Pat. 184903. *Pat. Off. Rec.* (June, 1918) **46**, 1792–3.

ELECTRIC welds. E. E. Thum, *Chem. & Met. Engng.* (Sept. 15, 1918) **19**, 301–8.

ELECTRIC welding, application to ship construction and repair. *Elect. Times* (Aug. 29, 1918) **54**, 131; *Elect. Rev.* (Sept. 6, 1918) **83**, 238–9; *Shipbldg. & Shipping Rec.* (Aug. 22, 1918) **12**, 186–8.

ELECTRIC welding machine. J. M. Sparkes. Canad. Pat. 184862. *Pat. Off. Rec.* (June, 1918) **46**, 1772.

ELECTRIC welding as applied to steel ship construction. *Engng. & Contr.* (Sept. 25, 1918) **50**, 308–9.

ELECTROLYTIC process of producing iron. A. T. C. Estelle, U. S. Pat. 1275161. *Off. Gaz.* (Aug. 6, 1918) **253**, 231.

ENGLAND, iron and steel industries in. Industries du fer et de l'acier en Angleterre. *Echo d. Mines* (Aug., 1918) 389–92.

FERRO-ALLOYS, manufacture in Colorado. R. M. Keeney, *Engng. & Min. Jnl.* (Aug. 31, 1918) **106**, 405–9. *Min. Jnl.* (Sept. 7, 1918) **122**, 522–6. Serial. From A. I. M. E. *Bull.* 140.

FERROMANGANESE, Electric. *Iron Age* (Sept. 26, 1918) **102**, 747.

FERROMOLYBDENUM, Making. *Iron Age* (Sept. 12, 1918) **102**, 624–5.

FERROMOLYBDENUM. R. M. Keeney, *Canad. Min. Jnl.* (Sept. 15, 1918) **39**, 318. From A. I. M. E. *Bull.* 140.

FERROTUNGSTEN, Making, in electric furnace. *Iron Age* (Sept. 26, 1918) **102**, 786–7. From A. I. M. E. *Bull.* 140.

FLUIDITY of molten cast iron. M. Riddell, *Foundry Tr. Jnl.* (July, 1918) **20**, 364–6; *Foundry* (Sept., 1918) **46**, 408–11. Read before British Foundrymen's Assoc.

FLUX for use in brazing cast-iron and other metals. A. Figgins, U. S. Pat. 1275412. *Off. Gaz.* (Aug. 13, 1918) **253**, 326.

FOUNDRY system. O. L. Dosch, U. S. Pat. 1276039. *Off. Gaz.* (Aug. 20, 1918) **253**, 530.

FUEL economy in blast furnace. T. C. Hutchinson, *Iron Age* (Sept. 19, 1918) **102**, 689–91.

FURNACES, Electric, for heat treatment. *Iron & Coal Tr. Rev.* (Aug. 9, 1918) **97**, 152.

FURNACES, electric, an automatic control. *Iron & Coal Tr. Rev.* (Aug. 9, 1918) **97**, 154.

GRAPHITE, formation in the iron-carbon series of alloys. J. E. Hurst, *Engng.* (Aug. 30, 1918) **106**, 217–8.

HARDNESS of soft iron and copper compared. F. C. Kelley, *Advance copy* No. 3. Am. Electrochem. Soc. 45–8.

HEAT treating furnaces. C. R. Inman, British Pat. 117301. *Ill. Off. Jnl.* (Sept. 4, 1918) 1936.

HEAT treatment of track-rails. C. P. Sandberg, U. S. Pat. 1277262. *Off. Gaz.* (Aug. 27, 1918) **253**, 900.

HEAT treatment on the electrical properties of steel. E. D. Campbell and W. C. Down, *Jnl.* Am. Soc. Naval Engrs. (Aug., 1918) **30**, 589–96. Paper before Iron & Steel Inst. From *Engng.*

HEAT treatment of large forgings; method and apparatus. H. H. Ashdown, *Marine Engng.* (Aug., 1918) **8**, 193–7.

HEAT castings, apparatus. R. W. Wiederwax, U. S. Pat. 1275638. *Off. Gaz.* (Aug. 13, 1918) **253**, 388.

HIGH-speed steels, Pyrometry applied to the hardening of. J. O. Arnold, *Trans.* Faraday Soc. (June, 1918) **13**, 271–5.

INDIAN steel industry, aspects. *Iron Age* (Sept. 5, 1918) **102**, 554–7.

IRON age, Advent in South Africa. *South Afr. Min. Jnl.* (July 20, 1918), **27**, 260.

IRON, carbon and phosphorus. J. E. Stead, *Iron & Steel of Can.* (Sept., 1918) **1**, 323–33.

IRON, standards for protective finishes. E. P. Later, *Foundry* (Sept., 1918) **46**, 424–6.

IRON sponge. N. Staal, Canad. Pat. 185136. *Pat. Off. Rec.* (June, 1918) **46**, 1904.

LATIN American, metals and metal industries. P. F. Martin, *Metal Ind.* (Aug. 9, 1918) **13**, 86–7.

LIQUID fuel. W. M. Burdon, Perfectionnements aux fours métallurgiques chauffés au combustible liquide. French Pat. 486980 *Bull. Off. Propriété Indust.* (Mar. 21, 1918) **38**, 37.

LIQUID steel, determination of the temperature, under industrial conditions. C. Johns, *Trans.* Faraday Soc. (June, 1918) **13**, 280–8; *Tech. paper* 91, U. S. Bureau Standards.

LIQUID steel, temperature determination. A. McCance, *Trans.* Faraday Soc. (June, 1918) **13**, 309–10.

MANGANESE, Conserving, in steel production A. N. Diehl, *Blast Fur. & Steel Plant* (Sept., 1918) **6**, 366–7. From discussion by Author read before Am. Iron & Steel Inst.

MANGANESE steel, Development of magnetic susceptibility in, by prolonged heat treatment, C. F. Brush, *Proc.* Am. Phil. Soc. (Apr., 1918) **57**, 344–53.

MANGANESE steel. A. H. Greaves, British Pat. 117286. *Ill. Off. Jnl.* (Sept. 4, 1918) 1929.

METAL crystals. Theory regarding the adhesion of the crystals of metals. *Brass Wld.* (Sept., 1918) **14**, 259.

METAL extraction. Toronto Power Co. Canad. Pat. 185166. *Pat. Off. Rec.* (June, 1918) **46**, 1925.

MELTING and re-heating furnace, New. *Iron & Coal Tr. Rev.* (Aug. 30, 1918) **97**, 237.

METALLOGRAPHY and heat treatment of metals used in aëroplane construction. F. Grotts, *Chem. & Met. Engng.* III. (Sept. 1, 1918) **19**, 241–7. Serial. IV. (Sept. 15, 1918) **19**, 315–9.

MOLECULAR instability by magnetostriction. D. Hurmuzescu. Instabilité moléculair par la magnétostriction. *Rev. Gen. Elec.* (Aug. 17, 1918) **4**, 211–4.

MOLTEN cast iron, Laws concerning the fluidity. M. Ridell, *Canad. Machy.* (Sept. 19, 1918) **20**, 345–7.

Under the Lowest Roof the

Goodman Articulated Storage Battery Locomotive

operates safely and successfully. It is particularly adapted to mines working thin seams. For the battery is carried low, between the motors on the two bogy trucks, with only the small idle wheels beneath it. Consequently the deck of the locomotive is lower than is possible when battery must be placed above the large drive wheels of the ordinary mine locomotive. That is but one of the many details of construction which shows how this Locomotive is "de-

GOODMAN MFG. CO., Chicago, Ills.

New York	Birmingham	Cincinnati	Denver
Pittsburgh	Charleston, W. Va.	St. Louis	Seattle

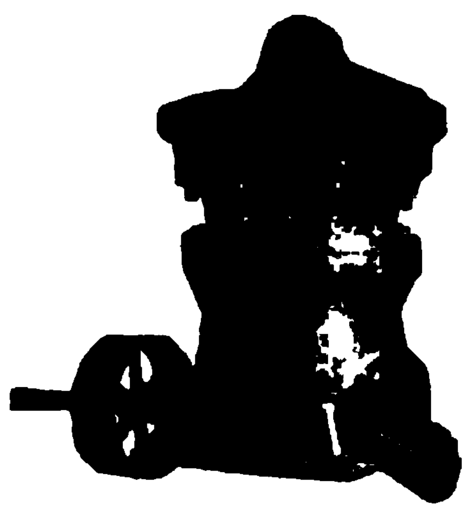
(65)

METALLURGY OF NON-FERROUS METALS

(See also Mineral Resources, Ore-dressing and Preparation of Coal, Coal and Coke, and Metallurgy of Iron and Steel.)

Silver-Lead, Copper and Pyritic Smelting Works, Sampling Works, Copper Bessemerizing Plants, Rock Crushing Plants, Stamp Mills, Chlorination Mills, Cyanide Mills, Cement Mills, Timber Creosoting Plants, Mine Equipment, Ore Drying Machinery, Power Transmission Machinery. Apparatus for Pulverizing and Burning Coal for Industrial Purposes. Woodbury System of Concentration, Pachuca Parral and Cyanide Tanks, Loomis-Pettibone Gas Generators, Suction Gas Plants and Oil Engines.

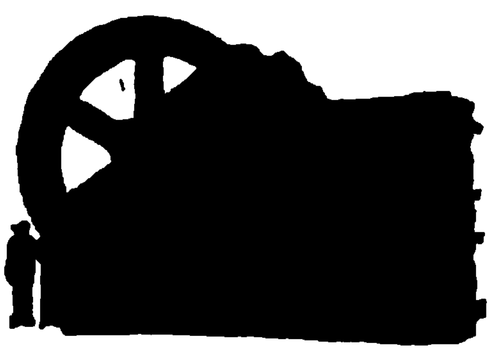
Write for Catalogs Upon the Above Subjects.



SUPERIOR McCULLY GYRATORY CRUSHERS
OUR NEW DESIGN (Patented)

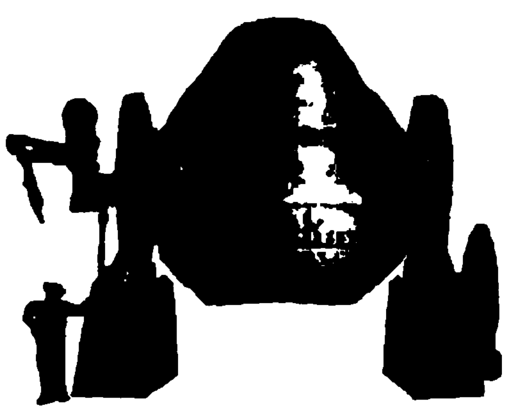
The Last Word in Gyratory Crusher Construction, Life of "Eccentric and Gears" Lengthened "200%," Because All "Dust and Grit" is Absolutely Excluded and "Cut Gears" run "Quietly in Oil," Main Shaft 60% Stronger than any Gyratory of Corresponding Opening: Area of Eccentric, 100% Greater than any Machine of Equal Size.

Capacities—30 to 1000 tons per hour, built in sizes from 10" to 54" opening. Ask for Bulletin of this new machine.



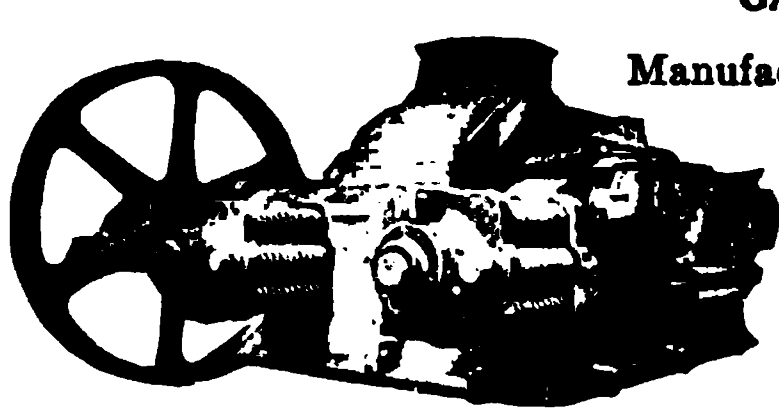
SUPERIOR JAW CRUSHERS

We were the Pioneer Builders of Large Jaw Crushers—Have More Large Machines in Operation than all other Manufacturers Combined—Repeat Orders for 84" x 60" Machines from Chile Copper Co.; Chino Copper Co.; Hardaway Co.; Luossavaara Kurunavaara Aktiebolag. Built in sizes from 36" x 24" to 84" x 66". *Capacities*—70 to 600 ton per hour. Ask for Bulletin No. 44.



COPPER CONVERTERS GT. FALLS TYPE

Manufactured in two distinct designs, known as the Cananea or Copper Queen type, and the Anaconda type. Both designs furnished with side or vertical blow tops, of any desired diameter opening. Number of tuyeres may range from 20 to 28, as desired. Blast connection may be placed on either side of converter.



GARFIELD CRUSHING ROLLS

Manufactured in a wide range of sizes, to meet the requirements of discriminating engineers, who demand an exceptionally efficient and worthy design. Most sizes of Garfield Rolls so constructed as to permit the use of *oversize* roll shells. A wide range of standard designs, and also several special types equipped with heavy, fly-wheel type pulleys.

WORTHINGTON PUMP AND MACHINERY CORPORATION

115 Broadway, - New York

Power and Mining Machinery Works, - - Cudahy, Wis.

M450.8

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Acids and Ammonia
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Acid, Sulphuric
Illinois Zinc Co., Peru, Ill.

Agitators
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Amalgamators
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corpn., 115 Broadway, New York City.

Asbestos
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Asbestos Materials
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Assay Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway New York City.

Axles, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Balances and Weights
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ball and Tube Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Bearings, Ball
Gwilliam Co., 253 W. 58th St., New York City

Bearings, Roller
Gwilliam Co., 253 W. 58th St., New York City

Belting, Conveyor
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Belting, Elevator
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio

Belting, Transmission
Goodrich Rubber Co., B. F., Akron, O.

Bins, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Blasting Powder (See Powder, Blasting)

Blasting Supplies
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Blowers
General Electric Co., Schenectady, N. Y.

Blowpipe Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Brake Blocks
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Brick, Fire
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Buckets, Elevator
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Burners, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Burners, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway New York City.

Cableways
Flory Mfg. Co., S., Bangor, Pa.
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis
Roebling's Sons Co., John A., Trenton, N. J.

Cages, Hoisting
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Cages, Self Dumping and Plain
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Car Lifts, Automatic
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Carbide Lamps
Macleod Co., Bogen St., Cincinnati, Ohio.

Cars, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Castings, Brass
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Castings, Iron
Fuller-Lehigh Co., Fullerton, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Caustic Soda
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Cement Blast Guns (See Guns, Cement)

Cement Machinery
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n. 115 Broadway, New York City.

Cements, Refractory
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Chains
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Chemical Apparatus
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Chemicals
Heil Chemical Co., Henry, 210-214 S. 4th St. St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Chrome Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Ore (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chute Plates & Launder Liners
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Chutes
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Classifiers
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo
Deister Concentrator Co., Fort Wayne, Ind.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Coal and Ash Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Mining Machines
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coal Mining Plants
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Storage and Rehandling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coatings, Roof
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Collectors, Dust
Macleod Co., Bogen St., Cincinnati, Ohio.

Compass, Maas Patent Drill Hole
Derby, Jr., E. L., Agent, Ishpeming, Mich.

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Concentrators
Colorado Iron Works Co., Denver, Colo.
Deister Concentrator Co., Fort Wayne, Ind.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Condensers, Surface
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Contractors, Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Converters, Copper
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Converters, Electric, Rotary
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Conveyors, Belt
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Conveyors, Cable Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Chain Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Pan or Apron
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Screw
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Core Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coverings, Pipe and Boiler
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Crucibles
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Crushers, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Crushers, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Heil Chemical Co., Henry, 210-214 S. 4th St. St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway New York City.
Traylor Engineering & Mfg. Co., Allentown Pa.
Worthington Pump & Machinery Corp'n. 115 Boradway, New York City.

Crushing Roll Parts
American Manganese Steel Co., McCormick Bldg.. Chicago Ill.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Crushing Rolls (See Rolls, Crushing)
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio

Cupro-Magnesium Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Cupro-Vanadium
Primos Chemical Co., Primos, Pa.

Cyanide
Roessler & Hasslacher Chemical Co., 100 William St., New York City

Cyaniding Equipment
Allis Chalmers Mfg Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver. Colo.
Dorr Co., Denver, Colo
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Dead Burned Magnesite
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Dewaterers
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa

Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

Dredging Machinery
Flory Mfg. Co., S., Bangor, Pa.

Drill Hole Compass (See Compass, Drill Hole)

Drills, Core
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Diamond
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Electric
Denver Rock Drill Mfg. Co., Denver, Colo.
General Electric Co., Schenectady, N Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio

Drills, Hammer
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Prospecting
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Rock
Denver Rock Drill Mfg. Co., Denver. Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Dryers, Ore
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa

Dryers, Rotary
Fuller-Lehigh Co., Fullerton, Pa.

Dryers, Sand and Gravel
Macleod Co., Bogen St., Cincinnati, Ohio.

Dumps, Rotary
Wood Equipment Co., McCormick Bldg., Chicago, Ill.

Dynamite
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Dynamos (See Generators, Electric)

Electrical Machinery
General Electric Co., Schenectady, N. Y
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa

Elevators, Bucket
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Emery Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

End Loaders (See Loaders, End)

Engines, Gas and Gasoline
Allis-Chalmers Mfg Co., Milwaukee, Wis.

Engines, Haulage
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Engines, Hoisting
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N Hazel St., Danville, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Engines, Oil
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City

Engines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Explosives
Du Pont de Nemours & Co., E. I., Wilmington, Del

Fans, Ventilating
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa

Feeders, Ore
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City
Traylor Engineering & Mfg. Co., Allentown, Pa

Ferro-Chrome
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa

Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa

Ferro-Molybdenum
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa

Ferro-Silicon
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa

Ferro-Tungsten
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa
Primos Chemical Co., Primos, Pa

Ferro-Vanadium
Primos Chemical Co., Primos, Pa.

Filtering Paper
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Filters
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Fire Clay
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Flotation, Oil
Colorado Iron Works Co., Denver, Colo.

Flue Welding Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Fluorescent Calcium Tungstate
Primos Chemical Co., Primos, Pa.

Fluorspar (Domestic and Foreign)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Forges, Oil and Rivet
Macleod Co., Bogen St., Cincinnati, Ohio.

Forgings, Heavy
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Fuller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Furnaces, Assay
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Electric
General Electric Co., Schenectady, N. Y.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Furnaces, Flue Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Lead
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Mechanical Roasting
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Furnaces, Muffle
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Reverberatory
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Smelting
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Furnaces, Tire Heating
Macleod Co., Bogen St., Cincinnati, Ohio.

Gears
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Generators, Acetylene Welding and Cutting
Macleod Co., Bogen St., Cincinnati, Ohio.

Generators, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Grinders, Sample
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Grizzly & Riffle Bars (For Hydraulic Mines)
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Guns, Cement
Macleod Co., Bogen St., Cincinnati, Ohio.

Guns, Concrete
Macleod Co., Bogen St., Cincinnati, Ohio.

Gyratory Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Hangers, Mine
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Hitchings Mine Car
Macomber & Whyte Rope Co., Kenosha, Wis.

Hoists, Electric
Allis-Chalmers Mfg. Co., Milwaukee. Wis.
Flory Mfg. Co., S., Bangor, Pa.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoists, Skip
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Hoists, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoppers, Weigh
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Hose, Air
Denver Rock Drill Mfg. Co., Denver, Colo.
Goodrich Rubber Co., B. F., Akron, O.

Hydrated Ferric Oxide (For Gas Purification)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Hydraulic Mining Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Insulators, Third Rail
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Jackets, Water
Traylor Engineering & Mfg. Co., Allentown, Pa.

Jaw Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Jigs
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Laboratory Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Lamps, Acetylene
Macleod Co., Bogen St., Cincinnati, Ohio.

Lamps, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Lead Acetate
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Linings, Ball and Tube
Traylor Engineering & Mfg. Co., Allentown, Pa

Linings, Brake
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Litharge
Heil Chemical Co., Henry, 210-214 S. 4th St., St. Louis, Mo.

Loaders, End
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Loading Booms
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio

Locomotives, Compressed Air
General Electric Co., Schenectady, N. Y.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Electric Trolley
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Locomotives, Gasoline
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Steam
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Storage Battery
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa

Low Carbon Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa

Magnesia Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesite Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesium Metal (Ingots and Powder.)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnetic Pulleys (See Pulleys, Magnetic)

Manganese Dioxide (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Manganese Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Meters, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Mica
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Mills, Ball, Tube and Pebble
Allis-Chalmers Mfg Co., Milwaukee, Wis
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n, 115 Broadway, New York City.

Mills, Chilean
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Mills, Stamp
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n. 115 Broadway, New York City.

Mine Car Hitchings (See Hitchings, Mine Car).

Molybdate of Ammonia
Primos Chemical Co., Primos, Pa.

Molybdate of Calcium
Primos Chemical Co., Primos, Pa.

Molybdate of Soda
Primos Chemical Co., Primos, Pa.

Molybdenum Metal
Primos Chemical Co., Primos, Pa.

Molybdenum Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Molybdic Acid
Primos Chemical Co., Primos, Pa.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Muffles
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ore-Bedding Systems
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Milling Machinery
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Worthington Pump & Machinery Corp'n. 115 Broadway, New York City.

Ores, Buyers and Sellers of
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Oxy-Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Packings, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.
Goodrich Rubber Co., B. F., Akron, O.

Painting Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Pipe Insulations
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Plate Metal Work
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Platinum Wire, Foil & Ware
Heil Chemical Co., Henry, 210-214 S. 4th St. St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Powder, Blasting
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Powdered Coal Equipment
Fuller-Lehigh Co., Fullerton, Pa.

Power Transmission Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa

Presses, Filter
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pulleys, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Pulverizer Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Pulverizers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Pulverizers, Coal and Coke
Fuller-Lehigh Co., Fullerton, Pa.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa

Pulverizers, Ore
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Acid
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Hydraulic Pressure
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Pneumatic Air Lift
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Pumps, Power
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Sand
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pumps, Sinking
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Stuff
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Track
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pyrometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Quarrying Machinery
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Quicksilver
Beer, Sondheimer & Co., 61 Broadway, New York City.

Refractories
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa

Respirators
Goodrich Rubber Co., B. F., Akron, O.
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.

Revolving Screen Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rock Drill Steel (See Steel, Drill)

Rods, Drill
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa
International High Speed Steel Co., 99 Nassau St., New York, N. Y.

Roller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rolls, Crushing
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Roofings, Asbestos and Rubber-type
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Rope, Wire
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rope Fastenings, Wire
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rubber Goods, Mechanical
Goodrich Rubber Co., B. F., Akron, O.

Samplers, Ore
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Scorifiers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Screens, Bar
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Screens, Perforated Metal
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Screens, Revolving
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Screens, Shaking
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Separators, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Shaft Sinking and Development Work
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Sharpeners, Drill
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Silica Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Skip Hoists (See Hoists, Skip)

Slings, Wire Rope
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Smelters
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Smelting Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Soda Ash
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Spelter
Illinois Zinc Co., Peru, Ill.

Spiegeleisen
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Sprockets
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Stamp Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Steel, Crucible
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.

Steel, Drill, Hollow and Solid
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
Denver Rock Drill Mfg Co., Denver, Colo.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Steel, Tool
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa
International High Speed Steel Co., 99 Nassau St., New York, N. Y.

Stokers
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Tables, Concentrating (See Concentrators)

Test Lead
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thawers, Switch
Macleod Co., Bogen St., Cincinnati, Ohio.

Thermometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thickeners, Slime
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.

Tipple Machinery Equipment
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Torches, Cutting and Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Towers and Bridges, Stocking and Reclaiming
Robins Conveying Belt Co., Park Row Bldg., New York City.

Tramways, Wire Rope, Aerial
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Transformers, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Traps, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Tungstate of Ammonia
Primos Chemical Co., Primos, Pa.

Tungstate of Soda
Primos Chemical Co., Primos, Pa.

Tungsten Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Tungsten Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Tungsten Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Tungstic Acid
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Turbines, Hydraulic
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Valves, Pump
Goodrich Rubber Co., B. F., Akron, O.

Vanadate of Ammonia
Primos Chemical Co., Primos, Pa.

Vanadic Acid
Primos Chemical Co., Primos, Pa.

Vanadium Chloride
Primos Chemical Co., Primos, Pa.

Vanadium Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Ventilating Fans (See Fans, Ventilating)

Wagon Loaders
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Weigh Hoppers (See Hoppers, Weigh)

Wheels
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Wheels, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Wire, Iron, Steel and Copper
Roebling's Sons Co., John A., Trenton, N. J.

Wire Mechanism (Lever Control)
Gwilliam Co., 253 W. 58th St., New York City.

Wire Rope (See Rope, Wire)

Wires and Cables, Electrical
General Electric Co., Schenectady, N. Y.
Goodrich Rubber Co., B F., Akron, O.
Roebling's Sons Co., John A., Trenton, N. J.

Zinc Dust
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Zinc Sheet
Illinois Zinc Co., Peru, Ill.

ALPHABETICAL LIST OF ADVERTISERS

(With Summary of Products)

See pages 28–39 for Classified List of Mining and Metallurgical Equipment

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

 [Please mention this BULLETIN when writing advertisers.]

ALPHABETICAL LIST OF ADVERTISERS (Continued)

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

Every electrical engineering and manufacturing facility of this company is being applied "without stint or limit" to the

"Give us Coal!" And Mule Power gives way to Electric Power

The arms of victory are forged in the nation's industrial plants. The bridge to France is the line of ships that stretches across the Atlantic. These must have sufficient coal.

Our coal mining industry made a world's record last year, despite many handicaps. In the anthracite mines alone, the labor shortage was 10 per cent., and the Government drafted many of the mules for the army's needs. Yet production increased 14 per cent. over the previous year.

How was it done? By better methods. By electrification. The electric mine locomotive, operated by one man, hauls a half dozen or more cars. Electric hoisting makes deep mining possible. Electrically operated ventilating fans safeguard the health of those toiling beneath ground. Electric coal cutters and drills save time and labor.

The cutting of timber for entrance ways, shoring and pillaring is speeded up by electric power. Additional motor-driven pumps are used to keep new and old workings dry, so that work proceeds without interruption.

Many coal operators looked to the General Electric Company for this assistance. G-E Mining Specialists responded by giving their attention to the problem confronting each mine and the great G-E manufacturing departments did their part by making prompt deliveries.

This year, the demands upon the mines and all industry are greater, and the labor supply scarcer, than ever before. The General Electric Company pledges its entire engineering and manufacturing facilities to every industry and individual manufacturer or operator engaged in essential war work.

43-65

Look for this—
the mark of leadership in electrical development and manufacture

GENERAL ELECTRIC COMPANY

General Office, Schenectady, N. Y.

DECEMBER, 1918

Bulletin of the American Institute of Mining Engineers

PUBLISHED MONTHLY

SPECIAL FEATURES

Bulletin of the American Institute of Mining Engineers

No. 144 DECEMBER 1918

CONTENTS

CURRENT MATTERS

TECHNICAL PAPERS

ADVERTISING

BULLETIN OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

PUBLISHED MONTHLY

No. 144 DECEMBER 1918

Published Monthly by the American Institute of Mining Engineers at 212-218 York St., York, Pa., H. A. Wisotskey, Publication Manager. Editorial Office, 29 West 39th St., New York, N. Y., Bradley Stoughton, Editor. Cable address, "Aime," Western Union Telegraph Code. Subscription (including postage), $10 per annum; to members of the Institute, public libraries, educational institutions and technical societies, $5 per annum. Single copies (including postage), $1 each; to members of the Institute, public libraries, etc., 50 cents each.

Entered as Second Class matter January 28, 1914, at the Post Office at York, Pennsylvania, under the Act of March 3, 1879.

UNITY OF PURPOSE AND SERVICE

To the members of the A. I. M. E., who have given much and risked all to fight "Over There" with pick, or gun, or brain, and to the members who have chosen the sometimes more self-denying duty of remaining at home to help produce metals for fighters:

Your experience in foreign lands has bred in you that spirit of internationalism which will soon be infused into every corner of our country by virile lads thrilling from a great experience in an old, yet new, land over the seas. To them the East will not seem as far from the West as it was, nor the North from the South. Sectional jealousies will seem despicable to one who has fought for a great ideal shoulder to shoulder with real men of other nations. And they who have willingly sacrificed much on the altar of service will have little patience with an egotist, be he laborer, tradesman, capitalist or engineer.

The problems which peace brings to us are more difficult than those of war and their solution requires not only cool heads, tolerance, and wise judgment, but the "getting together" of sections and classes and individuals. The triumph of justice over individualism, represented by the draft law, must be repeated, for there are "slackers" in peace as well as in war, and the spirit of self-denial expressed in response to Liberty Loans, Red Cross, and Welfare drives and Food Administration appeals must live. We have only just begun to learn how to serve.

It is often claimed by our members that the engineer is not given, in the community at large, the recognition which his training should merit; that his reward is not as great nor his service as welcome as it should be. Public service is generally assumed to be a logical activity for a lawyer,

a banker, a tradesman, etc., but the problems peace now brings can best be solved by the engineer. Many have done great service during the war because they grasped the first opportunity. They did not wait to learn whether the honor or reward attached to it was "good enough" for them. Other engineers, at the end of the war are still waiting for an offer they are willing to accept. But there is work enough for all in the time of reconstruction and readjustment and we shall find it in proportion to our true willingness to serve generously, but our perseverance may be taxed harder than that of classes of citizens who have been identified longer with public work. Among these problems is the very difficult readjustment that must take place in the relations between capital and labor. The engineer is not of either class but deals intimately with both. Who is better able to educate labor to understand the problems of the capitalist or to correct in the mind of the capitalist misconceptions as to the aspirations and needs of the laborer? Also, there are problems incident to the future relative importance of competition and coöperation in industry; of the disposition of the railroads, and many others which will readily occur to all engineers. A genuine desire to serve will bring us all together and then we shall be better able to help solve the problems that will arise in every community.

REPORT OF THE NOMINATING COMMITTEE

The report of the Nominating Committee, presented at the meeting of the Board of Directors on Oct. 25, 1918, is as follows:

	District
For *President:*	
HORACE V. WINCHELL, Minneapolis, Minn.	4
For *Vice-Presidents:*	
EDWIN LUDLOW, Lansford, Pa.	2
A. R. LEDOUX, New York, N. Y.	0
For *Directors:*	
J. V. W. REYNDERS, New York, N. Y.	0
GEORGE D. BARRON, Rye, N. Y.	0
Charles F. Rand, New York, N. Y.	0
LOUIS S. CATES, Ray, Ariz.	7
STANLEY A. EASTON, Kellogg, Ida.	5

Signed R. V. NORRIS, *Chairman*,
WALTER H. ALDRIDGE,
D. W. BRUNTON,
WALTER DOUGLAS,
A. C. LANE,
C. H. MACDOWELL,
C. W. WHITLEY.

1919 DUES

In accordance with the provision of the Constitution, notice is here given to all Members, Associates, and Junior Associates, that the dues of the year 1919 will be payable on Jan. 1, 1919, at the office of the Secretary. The dues for Members and Associates are $12 per year and the sum of $2 additional is asked of those Members and Associates who desire to have the two volumes bound in the Institute's standard binding.

The dues of Junior Associates are $5 per year.

TRANSACTIONS WANTED

The Institute's stock of Volumes XXXI, LI, and LII has become much reduced by sales. If members have copies of these volumes which they can spare, the price of $3 per volume will be paid for them, if in good condition. If desired, a copy of the Index for Volumes XXXVI to LV will be given for one of these volumes of the Transactions and one dollar additional. For two volumes of the Transactions, a copy of the Index will be sent and the balance will be credited to the payment of dues.

VOL. LIX

Vol. LIX will be shipped during December to all Members whose 1918 dues are paid on or before Nov. 15.

NEW YORK MEETING, FEB. 17 to 20, 1919

The program for the Annual Meeting to be held in New York, Feb.17 to 20, 1919, inclusive, has been nearly completed. Besides the usual meetings for the reading of technical papers, the social features are being given special attention. They will probably embody the following:

On Monday evening, a lecture by one of our fighting airplane pilots, to be illustrated by lantern slides and moving pictures. To this entertainment the ladies will be invited, as well as members. On Tuesday evening, a Smoker at which some very startling features are promised for the entertainment of members. On Wednesday evening, the usual banquet, at which it is hoped to have some very interesting speakers.

The usual luncheons will be served in the Engineering Building and other features will be offered for the entertainment of the ladies during the day. No definite plans for the Thursday excursion have yet been formulated, though it is probable that something interesting will be offered the members.

The chairmen and personnel of the various committees so far include:

Arrangements—ALLEN H. ROGERS, *Chairman;* W. S. DICKSON, *Secretary;* J. E. JOHNSON, JR.; H. C. PARMELEE; F. T. RUBIDGE; FOREST RUTHERFORD; F. H. BALL.
Finance—GEORGE D. BARRON, *Chairman.*
Banquet—A. C. LUDLUM, *Chairman;* F. T. RUBIDGE; E. B. STURGIS.
Luncheon—FOREST RUTHERFORD, *Chairman;* E. MALTBY SHIPP.
Evening Entertainments—E. P. MATHEWSON, *Chairman;* LAWRENCE ADDICKS; J. PARKE CHANNING; LUCIUS W. MAYER.
Patriotic Meeting—H. C. PARMELEE, *Chairman.*

PROCEEDINGS OF THE ONE HUNDRED EIGHTEENTH MEETING OF THE INSTITUTE, MILWAUKEE, WIS.

The 118th meeting of the Institute was under the auspices of the Institute of Metals Division and the Iron and Steel Section, and was held at Milwaukee, Wis. The opening session was a joint meeting with the American Foundrymen's Association and the American Malleable Castings Association, and was presided over by Benjamin D. Fuller, President of the American Foundrymen's Association. At this time Hon. Emanuel

L. Phillipp, governor of Wisconsin, welcomed the visitors to the city. He said: You will find the people of Milwaukee and of this commonwealth hospitable and above all in complete sympathy with you for the splendid work you are doing, and although, as you pass through the great shops of the city some one may answer you in a foreign tongue, we are all Americans.

The uppermost thought in the minds of the American people, wherever they may assemble, is the winning of the great world war. Without that success, there might be no further reason why we should meet: someone else might tell us what we should do. But we have progressed far enough in that struggle to begin to see the end and it is our kind of an end that we are seeing. In the name of humanity, let us hope that that end will come soon; but in the meantime let us stand firmly together, let us keep the wheels turning until the last gun is fired.

Insomuch as there is every reason for believing that the war cannot last very much longer, it is time that we began to think of what is going to happen and what we are going to do when the war is over. I take a rather optimistic view of that time. I appreciate that some economic changes will come to us, but I do not believe that the business of the country is going to be immediately stagnated or that in the immediate future, at least, there is going to be anything like a paralysis of industries. There is so much in waiting that must be done. One of the first demands will be the improvement of our transportation facilities. The great railroads of the country are wearing out, because it is impossible to secure the labor or the material to keep them in proper repair; but we must do more than merely repair them. The demand is going to come for cheaper transportation. We are urging the young men to go upon the farms. That is right and proper. Agriculture presents the very best field for the young man returning from military service. However, the farmers of this western country are going to demand better prices than they received before the war. One of the things that can be done to help them get better prices is to furnish transportation at a minimum cost. That will necessitate the purchase of millions of tons of steel. Not only must the tracks be rebuilt and the grades cut down, but the equipment of the railroads must be renewed and the balance of the road rebuilt to meet the demands of a really first-class modern railroad. Public building is being delayed until we can better spare the labor and the material than we can now. So, as I look over the needs of the country, I cannot see why there should be any business depression for many years after the war. I do not mean to say that war prices can be maintained; perhaps they ought not to be. Gradually we must get back to the level that normal times can support. However, the prospect for the future is not so gloomy. Europe is going to furnish a market for our agricultural products for some time and will demand our manufactured material. Besides, we are creating a merchant marine, which will open to us the commerce of the world.

You have assembled here for purposes of your own and, as the Governor of Wisconsin, I am glad you came to us. You brought to us your thoughts and new ideas in manufacture, in the particular line in which you are engaged, and we may be able to give you some information which will be for the mutual good. Happen what will now, let us stand together as one great coöperative organization, keep the wheels going, and, as the boys sing, "Keep the Home Fires Burning."

SECRETARY BACKERT introduced the following communication from a former president of the Association:

CAPT. R. A. BULL.—If I occupied with the American Expeditionary Forces a position of exposure to dangers and hardships, or if I performed a relatively important function in the military organization in France, I would hesitate to voice my sentiments, which in either case might be mistaken for self-praise.

Many things must be done by the non-combatant branches of the American army in France, back of the battle lines, in what is called the Service of Supplies. Those who are doing this work make no pretensions to performing the tasks of heroes, and feel the more keenly their great obligations to their comrades at the front, because of their own assignments in the rear. Many of them have seen, as I have, what a wreck of the yet living body can be made by the enemy's bullet, shell, bomb and gas; have witnessed the fortitude of wounded men under intense suffering; have observed the morale of our soldiers detained for treatment in the rear, keenly anxious to return to the trenches to settle the score with Fritz. Seeing all of this, and realizing how effectively he is hitting the Boche line, my respect for the Yankee fighting man, whatever may be his rank, is supreme. Many of the youths who man the guns, who carry the cold steel over the top, who bridge the streams under the enemy's fire, who minister to the wounded where they fall, are your own kinsmen. How proudly you must bear yourselves in the knowledge that those of your own flesh and blood are bearing this burden! And if perchance those whom you love must make the supreme sacrifice, how glorious a heritage their dauntless courage will leave to you!

It is always comforting to know that our own are in good hands. You have been informed through many channels that the American soldier in France is well cared for. I want to add my endorsement. The medical corps is zealous in its care for the sick and wounded, and in sanitary work. The strictest attention is given to drinking water. Troops quartered in barracks are housed with special regard for ventilation and cleanliness. In the camps in France where I have been stationed there are excellent bath houses, better than those at the camp in the states where I was formerly on duty. The quartermaster corps is rendering very efficient service in procuring and distributing clothing and other supplies. In most localities, and where conditions permit, the army messes have the most wholesome food, in liberal quantities, well prepared. There is no lack of sugar, wheat flour or meat in the American Expeditionary Force, mainly due, as we realize, to the cheerful self-denial of the folks back home. Just as rapidly as our troops arrive do their supplies seem to precede them.

The American Red Cross is surpassing all its magnificent traditions. It is found everywhere in France, seeking to serve, leaving with those who have felt its influence, grateful recollections that will never fade. Its chief function of caring for those selected by fate as the victims of the enemy's instruments of torture and suffering is being performed with the greatest skill and dispatch, in superb defiance of danger to those who minister. The inspiring devotion of its hard-working, consecrated men and women will constitute one of the most glorious memories of this conflict. Linked as its activities are with every patriotic home in America, its appeal to the sentiment of the Yankee in France makes it his ideal of devoted service that never fails.

The needs of the "Armée Américaine" have been thoughtfully considered apart from purely physical comforts. At the convalescent and rest camps every available means is supplied for cheerful, wholesome entertainment and recreation, with splendid effect on the spirit of the men. By long odds the greatest single factor in maintaining, day in and day out, the morale of the American soldier is the Y. M. C. A. There is the atmosphere of a democratic club, the resort of the finest type of man that has been created—the Yankee buck private.

Tribute has been paid to the splendid work of our allies countless times. After four of the most trying years through which any nation could pass, the French maintain their poise and their vigor to a degree that is amazing. Unstinted praise is demanded by such an inspiring demonstration. The British soldier is entitled to our admiration without bounds. He has been a complete failure—as his own press-agent. As a tenacious, courageous bull-dog who quietly fights on until he or his adversary is done for, he merits our highest esteem. John Bull's allies are under an enormous obligation to these reticent chaps who went quickly from the British Isles and Colonies to the rescue of Belgium and France, and who, without any fuss, have been doggedly seeing the thing through. Do not forget the debt of America to the British navy. And remember that the British empire has to date furnished about 8½ millions of her very best men to save democracy.

I can appropriately testify to the earnest appreciation of the men in the American Expeditionary Force for the splendid work being done by the industrial army in the states. We realize that millions of men and women and many children must labor in America that the vast numbers of her sons in Europe may have the means to finish their task quickly. And we regard those who are unceasingly rendering this service at home and who are best qualified for it, as equal in devotion to duty with those who wear the overseas cap. You realize that every moment of time or ounce of energy wasted in the United States increases the casualty lists of our army. Those who are going through Hell for you and me are confidently looking toward America for that supreme manifestation of speed and efficiency of which her people are capable. Being near to but not of these heroes, without credentials from them but voluntarily speaking for them as an individual, I salute you as brother-patriots, whose sole purpose now is the preservation of liberty for our own and future generations.

The following resolution pledging to the Government the united resources of the iron and steel industry was then unanimously passed:

RESOLVED, by the American Foundrymen's Association, the Institute of Metals Division of the American Institute of Mining Engineers, the Iron and Steel Section of the American Institute of Mining Engineers, the American Malleable Castings Association and the foundry equipment manufacturers of the United States in joint meeting assembled, that every resource of these allied metal trades is again pledged to the Government not only in the production of materials for the conduct of the war, but for the accelerated manufacture of these materials to enable the Government to greatly intensify its prosecution of the war and to bring about a speedy and crushing defeat of the enemy that will lead to his abject and unconditional surrender.

The activities of the army ordnance department, especially as applied to foundry matters, were told by C. S. Koch, of the Cannon Section of the Production Division, Ordnance Department, Washington. Coöperation between the railroad administration and the metal-working industries was then urged in an address of this title by E. D. Brigham, manager iron ore, coal and grain traffic, United States Railroad Administration, Duluth. The modern methods of transferring skill, illustrated by military films, were shown by Major Frank B. Gilbreth, Providence, R. I.

INSTITUTE OF METALS DIVISION

The first meeting of the Institute of Metals Division was held at the close of the joint session, with Chairman W. M. Corse presiding. In his address, Chairman Corse said:

The most important event of our year is the affiliation of our Institute with the American Institute of Mining Engineers. It gives us the opportunity of meeting twice a year and of associating, in at least one of these meetings, with men representing the produce of the metals that we all use. The opportunity to study the raw material end of our business has not been afforded at our meetings heretofore and should prove of great value to our members. The affiliation with the American Institute of Mining Engineers gives a permanent headquarters in New York city, the use of the large engineering library in the Engineering Societies' Building, and a permanent secretarial and editorial staff. We, on the other hand, must do our part in making the meetings of our division a success, both by writing papers and by participating in the discussions. Our meetings are generally considered to be excellent from a discussion standpoint. Let us maintain this feature in our divisional

meetings and interest in them men who are informed on subjects related in any way to the non-ferrous metal industry.

In these war times, it is particularly necessary to prepare for the reconstruction period to follow by perfecting our manufacturing processes and studying the most efficient methods of transacting our particular business. Any society whose aim is educational has a duty to perform in this respect, and as we represent the non-ferrous alloy and metal industries, it is incumbent on us to see that we are informed of the best and latest practice and furnish the medium for its wide dissemination. The need for maximum production is so great at the present time that it is difficult to find time to do research work, but it seems to be very necessary that we set aside some money and time in order that we may be ready to produce at the lowest cost and in the most efficient manner, when the times become normal. Our efforts in this direction, through our coöperative work with the Bureau of Standards, have been halted during the war, but it is our intention to continue this coöperative work as soon as practicable.

Our Institute has been the means through which much help has been rendered to the Government and our present affiliation puts us in a position to be of maximum help in this respect. Many of our members have rendered splendid service in technical capacities to the United States, for which we are very glad.

It gives me pleasure to see the generous manner in which our men have responded to any calls made on their time and experience. Let us resolve to make our Institute of Metals Division more of a power in the metal world and to carry on our meetings in such a way that the American Institute of Mining Engineers will feel that they have acquired an energetic and useful member in their household. I want to thank the membership for the coöperation they have given me during the year and for the splendid response to our new plan of organization. May the Institute of Metals Division of the American Institute of Mining Engineers be a worthy member of the metallurgical family of which we are now a part.

Secretary F. L. Wolf reported that:

The Institute, on July 1, 1918, had an active membership of 337 and an associate membership of 49, making a total of 386. In the active membership are included the corporation members, each corporation having three members.

Beginning July 1, 1918, the American Institute of Metals became the Institute of Metals Division of the American Institute of Mining Engineers. The advantages of this union were explained in the letter sent to the members on April 18. We retain our identity, elect our own officers as heretofore, hold our meetings as before, at the same time and place as that held by the American Foundrymen's Association and, in addition, a meeting in February, which is held at New York with the American Institute of Mining Engineers. By this affiliation, we secure all the advantages that are offered by one of the largest and best known scientific societies. A glance at our program will show that an excellent program has been provided by the Papers Committee of which Dr. Paul D. Merica is chairman.

The receipts and disbursements for the period of July 1, 1917 to Oct. 5, 1918 are as follows:

Receipts

Cash on hand July 1, 1917	$ 740.04
Dues	3610.50
Volumes	783.96
Emblems	21.00
Interest	2.00
Refund from Rumford Press	19.25
Rental of Electros to Metal Industry	5.00
A. F. A.	250.00
Miscellaneous	.37
	$5432.12

Disbursements

Printing including Postage	$3202.98
Postage	114.15
Salaries	1025.00
Office Supplies	19.91
Refunds	50.25
Bond	2.50
Insurance	37.62
Convention	236.10
Miscellaneous	25.49
Exchange	7.85
Cash on hand Oct. 5, 1918	710.27
	$5432.12

As officers for the ensuing year, the nominating committee, consisting of Gwilliam H. Clamer, chairman, J. L. Jones, and Alfred Frank, recommended the following, for whom the Secretary was instructed to cast the ballot: *Chairman*, W. M. Corse, Ohio Brass Co., Mansfield, O.; *secretary-treasurer*, F. L. Wolf, Ohio Brass Co., Mansfield, O.; *vice-chairmen*, who will also form the executive committee, Wm. B. Price, Scovill Mfg. Co., Waterbury, Conn.; George K. Burgess, Ph. D., Bureau of Standards, Washington, D. C.; Harold J. Roast, James Robertson Co., Ltd., Montreal, Can.; C. H. Bierbaum, Lumen Bearing Co., Buffalo, N. Y.; W. A. Cowan, National Lead Co., Brooklyn, N. Y.; Sir Robert A. Hadfield, 22 Carlton House Terrace, London, Eng.; W. K. Frank, Damascus Bronze Co., Pittsburgh, Pa.; C. H. Mathewson, Ph. D., Scheffield Scientific School, New Haven, Conn.; Zay Jeffries, Ph. D., Aluminum Castings Co., Cleveland, O.; W. H. Bassett, American Brass Co., Waterbury, Conn.

TECHNICAL SESSIONS

Institute of Metals Division

One session of the Institute of Metals Division was held on Tuesday morning, October 8, Mr. W. M. Corse presiding. The following papers were presented:

The Metallography of Tungsten. By Zay Jeffries. (Presented by the author; discussed by Sir Robert Hadfield, J. C. W. Humfrey, P. D. Merica, and the author.)

Notes on Babbitt and Babbitted Bearings. By Jesse L. Jones. (Presented by the author; discussed by G. H. Clamer and the author.)

The second session was held on Wednesday morning, October 9, Mr. W. M. Corse presiding. The following papers were presented:

Constitution of the Tin Bronzes. By S. L. Hoyt. (Presented by P. D. Merica; discussed by C. H. Bierbaum.)

Oxygen and Sulphur in the Melting of Copper Cathodes. By S. Skowronski.
Relation of Sulphur to the Overpoling of Copper. By S. Skowronski.
(Both papers were presented by W. H. Bassett, and discussed by F. Johnson (written), G. H. Clamer.)
Pure Carbon-free Manganese and Manganese Copper. By Arthur Braid. (Presented by the author; discussed by W. H. Bassett, G. H. Clamer.)

The third session, a symposium on the conservation of tin, was held on Wednesday morning, October 9, immediately following the session scheduled above, and was continued on Wednesday afternoon. Mr. G. C. Stone was in the chair. The following papers were presented:

Babbitts and Solder. By G. W. Thompson. (Presented by W. A. Cowan.)
Bronze Bearing Metals. By G. H. Clamer. (Presented by the author.)
Pennsylvania Railroad Anti-friction and Bell Metals. By F. M. Waring. (Presented by W. M. Corse.)
Solder, Its Use and Abuse. By M. L. Lissberger. (Presented by the author.)
The Tin-plate Industry. By D. M. Buck. (Presented by the Chairman; discussed by G. H. Clamer, J. W. Richards.)
The Aluminum Bronze Industry. By W. M. Corse. (Presented by the author.)
Bronzes, Bearing Metals, and Solders. By G. K. Burgess and R. W. Woodward. (Presented by P. D. Merica; discussed by G. H. Clamer, R. T. Roberts.)
Cadmium Resources of the United States. By C. L. Siebenthal. (Presented by P. D. Merica; discussed by M. L. Lissberger, C. W. Hill, F. F. Colcord.)

The fourth session was held on Wednesday afternoon, beginning at the close of the symposium on tin. Mr. W. M. Corse presided. The following papers were presented.

The Volatility of the Constituents of Brass. By John Johnston. (Presented by the author; discussed by J. W. Richards.)
The Effect of Impurities on the Hardness of Cast Zinc or Spelter. By G. C. Stone. (Presented by the author.)
Dental Amalgams. By A. W. Gray. (Presented by the author, and illustrated by lantern slides.)

The fifth session was held on Thursday morning, October 10, Mr. G. C. Stone presiding. The following papers were presented:

Electrolytic Zinc. By C. A. Hansen. (Presented by title. Written discussions by J. L. McK. Yardley and the author.)
The Condensation of Zinc from its Vapor. By C. H. Fulton. (Presented by C. C. Nitchie; discussed by E. E. Thum.)
The Action of Reducing Gases on Copper. By N. B. Pilling. (Presented by the author.)
Notes on Non-metallic Inclusions in Bronzes and Brasses. By G. F. Comstock. (Presented by title.)
Fusible Plug Manufacture. By G. K. Burgess and L. J. Gurevich. (Presented by title.)
Application of the Spectroscope to the Chemical Determination of Lead in Copper. By C. W. Hill and G. P. Luckey. (Presented by C. W. Hill.)
Radium. By R. B. Moore. (Presented by title. Written discussion by W. A. Schlesinger.)

Iron and Steel Section

The session of the Iron and Steel Section was held on Wednesday morning, October 9, Dr. J. W. Richards presiding. The following papers were presented:

The Engineering Work of the National Research Council. By H. M. Howe. (Presented by John Johnston.)

The Limonite Deposits of Mayaguez, Mesa, Porto Rico. By C. R. Fettke and Bela Hubbard. (Presented by title.)

The Manufacture of Ferro-alloys in the Electric Furnace. By R. M. Keeney. (Presented by title. Written discussion by E. S. Bardwell, H. W. Gillett.)

The Manufacture of Silica Brick. By H. LeChatelier and B. Bogitch. (Presented by title.)

Notes on Certain Iron-ore Resources of the World, N. Y. Section Meeting of May 23, 1918. (Presented by title. Discussed by J. W. Richards.)

Recent Geologic Development on the Mesabi Iron Range, Minn. Discussion by Anson A. Betts and J. F. Wolff. (Presented by title.)

The Byproduct Coke Oven and its Products. By W. H. Blauvelt. (Presented by title.)

The Use of Coal in Pulverized Form. By H. R. Collins. (Presented by the author; discussed by A. V. Adamson, J. W. Richards, H. H. Stoek, R. F. Harrington, T. A. Marsh, and the author.)

Carbocoal. By C. T. Malcolmson. (Presented by N. W. Roberts.)

Low-temperature Distillation of Illinois and Indiana Coals. By G. W. Traer. (Presented by the author.)

Method of Fixing Prices of Bituminous Coal Adopted by the U. S. Fuel Administration. By Cyrus Garnsey, Jr., R. V. Norris, and J. H. Allport. (Presented by title. Written discussion by E. McAuliffe.)

MEETING OF BOARD OF DIRECTORS

At the meeting of the Board of Directors held on October 25, the reports of the Treasurer and the Nominating and Finance Committees were received. Thirty-five members, seven associates, and six junior associates were elected; one change of status from junior associate to member was granted; six members were reinstated; and one resignation was accepted. An extension of time was granted to fourteen members. The dues of forty-seven members were suspended on account of their being in active service.

The application for formation of a Houghton Section was granted and the president was authorized to appoint a committee on organization. The courtesies of the Institute were extended to visiting engineers of France, Great Britain and Italy who are at present in the country on war missions. Votes of thanks were extended to the Committees of the Milwaukee meeting. The proposed Survey of Engineering Organizations by Engineering Foundation was approved. The Secretary was authorized to publish in the *Bulletin* an appeal from the American Ouvroir Funds. A petition signed by 110 members of the Institute to change the name of the Institute was presented.

Treasurer George C. Stone resigned on account of contemplated absence from the city, and George D. Barron was elected Treasurer in his place.

Mr. Alexandre Gouvy, a distinguished French engineer, then addressed the Board.

LOCAL SECTION NEWS

SAN FRANCISCO SECTION

ROY H. ELLIOTT, *Chairman* T. A. RICKARD, *Vice-chairman*
W. H. SHOCKLEY, *Secretary-Treasurer*, 959 Waverley St., Palo Alto, Cal.
D. M. RIORDAN C. F. TOLMAN, JR.

A joint meeting of the local sections of the several national engineering societies represented in San Francisco was held at the Engineers' Club on Thursday evening, Sept. 26, 1918. The subject for the evening, "Fuel Conservation," was ably discussed by a number of representatives of the Federal Administration and by engineers interested in the generation and utilization of all kinds of power on the Pacific Coast. The following extracts from papers presented at this meeting have been selected as being of the greatest interest and value to members of this Institute.

Problems of the Fuel Administration

ALBERT E. SCHWABACHER.—America's war needs call for 100,000,000 more tons of coal this year than in 1917, and 200,000,000 tons more than in 1914, when the war started, and this increase must come from a weaker man-power than that of 1917. It must be transported by a railroad system that has not been improved since the war started, and has been burdened with inconceivably greater demands than were made upon it before the war. This tremendous increased demand must be met by most intensive work in three directions; increased production, efficient conservation, and a distribution system which will insure against lost motion.

While every European country has decreased its coal production since the war began, the United States has mined 50,000,000 tons more coal, during the first year of the war, and will increase this by another 50,000,000 the present year. Every 8 days there are being mined and transported as great a weight of coal as of the entire wheat crop of the United States. Of the 735,000,000 tons of coal which must be made available for consumption by our railroads, ships, war industries and people, 100,000,000 tons will come from the anthracite fields, the remainder from the bituminous fields.

In 1917 there were produced about 330,000,000 bbl. of oil, and this year an additional amount over last year's production, of approximately 23,000,000 bbl. will be required. Water power developed 5,000,000 hp., the demand greatly exceeding the available supply.

Two limiting factors to the production of coal are labor and transportation. With a decreased labor supply, and increased demand, full production must be obtained by greater efficiency of mine workers and conservation by industrial and domestic consumers. The Production Bureau of the United States Fuel Administration has appointed a special committee in each mine. Three members are chosen by mine operators, and three by the workers. This committee urges miners to work 8 hours a day 6 days a week, to report the number of tons of coal produced, and to discourage shortages of hours or absence from duty, even on holidays. Young men attending school in the winter have been encouraged to work in the mines during the summer. As an example of

the patriotic efficiency evidenced by miners, the wonderful record of Marion Urbin for one month may be cited. In the Bliss colliery of the Lehigh & Wilkes-Barre Coal Co., he mined 350 cars of coal, and he had to remove 58 cars of rock, a total of 408 cars. His earnings were $350 for the month.

Before the war, the demand for domestic coal during the summer was so light that miners would often seek other occupations. The Fuel Administration has encouraged the early buying and storage of coal, by patriotic appeals to consumers through a "Buy Early" campaign. This has been a tremendous success, and has kept the demand upon many mines during the summer months up to maximum.

The Fuel Administration has created a Labor Bureau, wherein the matters pertaining to labor in the coal-mining industry remain under the jurisdiction of the United States Fuel Administrator. Strikes in the industry have been reduced to a minimum, thanks to the efficient work of this Bureau.

A zoning system which eliminates cross-hauling of coal, and avoids waste of transportation, is estimated to save over 20,000,000 car-miles a year in the movement of coal. A consequent saving of fuel that would otherwise be used in this transportation is also made.

Before the organization of the Fuel Administration, shipments of bunker coal to seaports contained as high as 10 per cent. foreign substance, such as bone and slate. Strict regulations now prohibit the delivery of any coal to Atlantic or Gulf ports for bunkering purposes that is not up to the Fuel Administration's specifications covering clean coal.

Fuel oil also must be conserved to the utmost, as in efficiency as a vessel fuel it has no equal. Mr. Rossetter, Director of Operations of the United States Shipping Board, advises that the emergency fleet can be operated by American seamen in competition with foreign vessels manned by cheap Asiatic labor, providing fuel oil is burned instead of coal. An equal weight of fuel oil gives more heat without smoke, requires less man-power to handle, and occupies much less bunker space than coal.

H. R. Collins, of the Fuller Engineering Co., states[1] that, from actual experience with many grades of coal, he believes that every solid carbonaceous fuel, from lignite to the graphitic anthracites of Rhode Island, will yield its maximum measure of heat if burned in pulverized form. The cement industry alone, in California, consumes 1,700,000 bbl. of fuel oil per annum. If California low-grade lignites and subbituminous coals were pulverized and utilized as fuel to serve this industry, approximately 350,000 tons of coal in the pulverized state would release for vessel fuel 1,700,000 bbl. of fuel oil.

The Fuel Administration is endeavoring to stimulate development of hydro-electric power to serve as a substitute for fuel oil and coal. Central generating stations are recognized to have far greater possibilities for fuel conservation than smaller isolated plants, and the elimination of less efficient plants is being urged. All power plants in the United States are now being inspected by engineers of the Fuel Administration, who make definite recommendations for any necessary im-

---

[1] *Bull.* No. 136 (April, 1918) 955.

provements in plant construction, operation or working conditions. In the event of a local fuel shortage, preference will be given to those plants which have adopted efficient operating methods recommended by the Fuel Administration.

Inter-connection of power companies has been accomplished in many localities through the efforts of the Fuel Administration. Substantial savings of fuel oil and coal have been made possible, particularly in those communities where water-power plants have been inter-connected with those operated by steam. By the closing or consolidation of many so-called "less essential" industries, supplies for fuel, raw materials and man-power have been made available for war industries.

In its efforts to secure sufficient fuel for our war industries and transportation companies, the Fuel Administration, in conjunction with the War Industries Board, has curtailed many less essential industries in varying degrees. Lightless nights are estimated to save 500,000 tons of coal per annum. Skip-stop systems on street railroads promise to save 3 per cent. of fuel consumption. The daylight saving plan will save approximately 1½ million tons of coal per annum.

With only slight expenditures, big results can be obtained in factories by the elimination of unnecessary lights and lights of too great candle power, of carbon lamps and arc lamps. The Fuel Administration also urges the substitution of nitrogen lamps and the washing of dirty windows. Discontinuance of motor power when machinery is idle, elimination of excessive sparking, heating or erratic speed of motors is recommended. Proper alignment of shafting, with grouping of machines so as to operate motors as nearly loaded as possible, and efforts to maintain a flat load curve are also urged.

Domestic consumers are urged to save fuel in their homes; most of this saving can be accomplished by proper damper control. Conservation throughout the country is a self-evident necessity. Still more radical curtailment of the supply of fuel to industries is essential to the carrying on of the war, and must be enforced.

Development of Water Power

A. H. MARKWART.—In developing the greatest natural resource of the country—our "white coal"—we have barely made a beginning; here is a supply of energy which is practically inexhaustible so long as the sun shines. The undeveloped water power of the nation has been variously estimated at from 55,000,000 commercially to 225,000,000 hp. theoretically. According to one authority, there is available at reasonable costs from 75,000,000 to 150,000,000 hp. Accepting the lower estimate of 55,000,000, it is stated that 40,000,000 of this is to be found in 13 Western states, and most of it is under Federal control because of the need of occupying Government land wholly or in part. There is perhaps 5,000,000 hp. in the state of California, but not over half a million is developed. The total developed water horse-power of the United States is given as about 6½ million, while the steam engine horse-power, including railroad locomotives, is placed at 28,000,000. It is evident that there are great water-power opportunities, many of which are favorably situated for immediate development to satisfy the needs of a wide and constantly increasing consumption.

At present the laws under which water power may be utilized are most unfavorable, with the disastrous result that there has been a stagnation in water-power development. While in normal times, policies were deterrent, in war times they are practically prohibitive, and the obstacles to be encountered are so numerous that corporations are reluctant to—in fact, cannot—undertake any expansion whatever. At present, to develop a hydro-electric project in California, one finds it necessary to obtain permits of the Forest Service (if public lands are involved), the State Water Commission, the Railroad Commission, the Commissioner of Corporations, and the Fuel Administration; and then, when all of these permits have been obtained, it is necessary to secure a certificate from the Capital Issues Committee that the issuance of the securities in connection with the project is not incompatible with the interests of the United States. But even this is not sufficient in these times, for after all this has been done, the War Industries Board, the Railroad Administration and the Selective Service Boards will determine respectively whether or not the necessary materials of construction may be obtained, transportation arranged, and men secured to accomplish the physical work. Of course, all these restrictions appear necessary to safeguard the interests of the public and to maintain the conduct of the war, but they do not facilitate the development of this enormous wealth of potential energy.

That the interests of the war will be best served by a reduction in the use of coal and oil, which are non-renewable natural resources, is apparent; and no one disputes the benefits to be derived by the use of a form of energy obtained from renewable sources. Moreover, it requires much less of the country's man-power to produce energy from water than from either coal or oil. It would therefore seem that sane, accelerant effort should be directed toward the utilization of hydro-electric power rather than toward the exhaustion of coal and oil, with the consequent waste of man-power and absorption of transportation facilities. Water power is now being conserved to the highest degree—in fact, it is locked up—by prohibitive restrictions. We should have done with this kind of conservation and should proceed with the development and utilization of this tremendous resource in order to save for posterity some of those non-renewable natural resources upon which this generation is drawing so heavily.

Fuel Oil for Ships after the War

DAVID L. FOLSOM.—If the United States is to meet successfully the industrial and political problems which will arise after the war it must be done through increased domestic development and through the expansion of our foreign commerce.

To the expansion of commerce we are already committed through the construction of the merchant fleet under the United States Shipping Board. In 1914, the total merchant fleet of the world was, in round numbers, 50,000,000 tons. A part of this has been destroyed by submarines and raiders, but by 1921 there will be under the American flag, and under the direction of a single organization, 25,000,000 tons of new ships. These ships must have some place to go and they must have something to carry. A great part of this fleet will undoubtedly operate

on the Pacific and every port and every industrial section of the Pacific must feel the impulse and the stimulus of increased trade.

If this is to be done, I believe that every boat which operates successfully on the Pacific under the American flag must be an oil burner, and that eventually these boats will be equipped with internal-combustion Diesel engines. There are two reasons for this. In the first place, the coaling stations of the world are under the control of either the English or Japanese nations; in the second, it is only through the use of oil that America can meet competition under the handicap of the high wages which this country pays its seamen.

Oil is the ideal fuel for ships: compared with coal, it is cheaper and easier to handle, more efficient in use, and gives a longer steaming radius to vessels. The amount of oil required to supply our new boats will tax our resources to the utmost. At present we are not producing in this country enough oil to meet our own domestic requirements, and the present estimates of the Shipping Board call for an additional 80,000,000 bbl., or 25 per cent. of the present production, for the support of the new merchant fleet. This can mean only one thing—a smaller consumption of oil on land. On the Pacific Coast this presents an acute problem worthy of the best talent in the engineering profession. Oil is our best fuel, and California oil supplies two-thirds of the power, light and heat over the western third of the United States.

If we are to expand our own trade and develop products to supply cargoes for our ships, we must have power, we must have fuel for factories, mines and farms. In face of the necessity for decreased use of oil, where is the Pacific Coast to get this power? I believe there is no single solution, but instead a joint solution to this problem. Oil must be used more efficiently both on land and on ships, through the development and increased use of the internal-combustion engines, and on land hydro-electric power must be developed and used on a greater scale than ever before.

The Use of Gas as a Conservation Measure

JOHN A. BRITTON.—As competitors with artificial gas for the generation of light, heat, and power, we have electricity, wood, coal, oil, and the residual products of crude oil.

Electricity has never measured up to the standard of other means of producing heat, while fulfilling every expectation as a means of affording light and power. Heat generated by electric resistance can never be a successful competitor of gas where the materials from which gas is derived are readily obtainable. And it is conceded that the cost of transporting coal and oil from which gas is made, to the point of manufacture, is materially less, per unit of heat, than the cost of conducting electric energy to the point of its conversion into heat. The use of electricity for heating, therefore, becomes at once an economic waste of material and man-power. The same truth would apply to lighting, except for the diversified uses of electric energy, its adaptability, and the freedom from personal care that is necessary in the use of gas and oil.

The lack of a good quality of bituminous coal in California renders its use as a competitor of oil or gas at once out of consideration. When we consider the enormous labor required in the mining, transportation, distribution, and consumption of coal, and the low efficiency in its appli-

2

cation for the production of heat, we can safely confine this discussion to the relative merits of oil and gas, oil of itself and oil transformed into artificial gas by the modern process which is essentially Californian in character.

In the modern process of gas manufacture from crude oil, it is safe to estimate that not more than 7 gal. of oil is used for all purposes in the production of 1000 cu. ft. of gas, having a thermal value of 550 B.t.u. per cu. ft. This gives 550,000 B.t.u. in 1000 cu. ft., 70 per cent. of which is applied to effective work in modern domestic appliances, and more when used in large industrial installations. The distribution of gas requires no transportation or man-power nor are these entailed in the disposal of residuals or byproducts. It is available to the smallest consumer as well as the largest, and is today a most important factor in war work.

Fuel Saving in England

CAPT. ROBERT W. A. BREWER.—The exacting demands which the war has made upon facilities for transportation to England from abroad, and in that country itself, have led to the utilization of home produced fuels in a more economical manner than previously, and have in some instances caused the substitution of coal products for oil and its products. It must be borne in mind that the production of oil in the United Kingdom is almost negligible, and that such oil as is produced is from the shale in the southern parts of Scotland.

Attention was immediately turned to an increase of the supply of oils from coal, a matter which had come to the public notice only a few years before the war. The recovery of tar had been carried out in a somewhat haphazard way and the distillation of benzol was conducted commercially only in a few of the largest gas works. The major portion of this benzol was exported to France and Germany. In the former country it was largely used for the propulsion of public-service vehicles in Paris. Germany, as we all know now, was extracting various substances necessary for the production of high explosives from the by-products of coal purchased in England. In the time immediately before the war, one or two houses in England marketed benzol for automobile purposes in a commercial way, obtaining a price about equal to that of gasoline, but the total volume of the business was very small.

The demands of the war for benzol and toluol were met by the coöperation of all the principal gas producers at the request of the Government, who, at their own expense, installed the Carpenter system for the recovery of these distillates from the tar. By the consent of the British Government, permission was given to strip the gas in order to fulfill the requirements for explosive materials and this does not appear to have affected the general situation, as in the extreme cases a further enrichment of the gas has been resorted to. The consumption of gas in place of coal has resulted in large economies and the figures reached, particularly for the arts, have been so large that the final cost of gas to the consumer has been reduced.

The demands for TNT warranted the British Government in erecting a factory at a cost of £1,500,000, which has provided sufficient capacity for producing this explosive at a cost of 17 c. per pound, whereas the market price was 42 c. per pound. In other words, this factory has

been able to produce at a cost of £3,500,000 a quantity of TNT which would otherwise have cost £7,000,000. On the other hand, there is the question of freight, and when this was most acute, it was reckoned that by purchasing explosives in America, a saving was made equal to four times the freight of the raw material.

All the gasoline and petroleum products going to England are imported from the East Indies, Borneo and Sumatra, and from the United States, Roumanian oil principally going to France and Germany before the war. A few months ago France was taking gasoline to the extent of 4,000,000 gal. per month; Salonica, 1,500,000 gal.; England, 1,000,000 gal.; and various smaller quantities to other seats of operations. The use of pleasure automobiles burning gasoline has been practically prohibited in England for a long time, and at one time attempts were made to run commercial vehicles and other smaller machines on coal gas, but changes in legislation from time to time appear to have affected the operation of this scheme. A prize of $5000 was offered about one year ago by the English Automobile Association for the most suitable method of utilizing coal gas on an automobile, but the writer believes that this offer has been withdrawn.

The success of gas as a fuel needs no question, and for the operation of busses has many points in its favor. Factories building engines for aircraft and automobiles have used gas very extensively for a long time for running these engines in the shops, and have effected a large saving thereby.

That the question of using city gas for the propulsion of vehicles in England is still receiving attention is shown by the fact that last month a London bus chassis was shown at an exposition fitted up with the necessary appliances for using gas, and, in the absence of detail, it must be assumed that an improved form of container is now being fitted to the chassis. Previously, gas was contained in collapsible bags on the roof of the bus, this system being very suitable for replenishment from point to point en route. As the cost of gasoline in England is about 90 c. per gal., a considerable saving of cost is effected when it is realized that at the prevailing price of gas in London, the equivalent amounts to 20 c. per gal. of liquid fuel. It can further be shown that the substitution of city gas at 50 c. per 1000 cu. ft. will effect a saving over petroleum distillate, at 10 c. per gal., not only when careful comparative consumption tests are made with the two fuels, when used in a factory, but also from the point of view of wastage and completeness of combustion; and even when the different costs of the fuels did not show a direct saving in careful test, the advantages of using gaseous fuel are so apparent that its adoption is fully justified.

Gas is also used to a very large extent and its use is increasing for furnace work, particularly muffle furnaces; and it has advantages, particularly for heating melting pots, and all similar purposes where an even temperature is required.

As to the coal industry, the cost is largely accounted for by transportation, and it became necessary not long ago for the Government to divide up the country into sections so that the consumption of fuel should take place as near as possible to the point of production. Where this did not balance out, surplus fuel, for example, was to be delivered into the nearest or most accessible district.

In conclusion, it may be stated that an important factor in the saving

of cost of fuel in England has been a remodeling of the method of handling; and in addition to the revised method of distributing coal, liquid fuel was recently transferred in bulk to France and put up in 2-gal. containers in a special factory in that country, thus saving the handling of the packages from England to France, which required several ships.

Other Papers

In addition to the foregoing papers, the following interesting contributions were presented, but as their substance relates more to electrical and mechanical engineering than to mining or metallurgy, we consider it possible to omit them:

The Relation of the Chemist to the Conservation of Fuel. By Prof. Edmund O'Neil.

Sources of Energy Supply. By E. M. Downing.

Electric Consolidations and Their Relations to Fuel Conservation. By H. G. Buckner.

Fuel Conservation Through Priority Regulations. By Major George F. Sever.

Railroad Electrification as a Fuel Conservation Measure. By W. J. Davis.

District Steam Heating as Related to Fuel Conservation. By Harry S. Markey.

These papers will probably be abstracted in the February *Journal* of the American Society of Mechanical Engineers.

AMBROSE SWASEY'S SECOND GIFT TO ENGINEERING FOUNDATION

Said Plutarch a long time ago, "To appreciate a man's work at the full, it is well to know the man himself, his circumstances and the incidents of his career." He might as truly have said "gift" instead of "work."

Ambrose Swasey, engineer, collaborater with scientists, promoter of engineering research, patron of Engineering Foundation, advancer of the good of mankind, modest gentleman and generous giver, is, happily, well known to a great many engineers, who will therefore more fully appreciate his recent additional gift, for the use of the Engineering Foundation, which purpose is "the furtherance of research in science and engineering, and the advancement of the profession of engineering and the good of mankind."

But full appreciation of a gift of money necessitates more than acquaintance with the giver and knowledge of the amount. Its timeliness; its inspiration; the character and continuity of its benefits, all must be comprehended. But whose imagination, though far-visioned as the great telescopes Mr. Swasey has built, can see the limits of benefit of such gifts as he has made to the Engineering Foundation, attracting—as they will—other gifts and evidences of devotion to a great cause? Every such gift lays responsibilities upon the recipients. Will American engineers grasp not merely their pecuniary value but also emulate the spirit of fraternity and desire for harmony which have accompanied them? Shall we not work together and with Ambrose Swasey to advance still further the good of mankind, thus to demonstrate an acceptance of our obligations to humanity which is a counterpart in a democracy of the *noblesse oblige* of aristocratic tradition?

Timeliness is a wonderful feature of Mr. Swasey's gifts. The first was made in the early stages of the present struggle of the nobler elements of the world against the ignoble, which has come to be "the people's war." It enabled Engineering Foundation to join with the National Academy of Sciences in responding to the President's request to bring into coöperation Governmental, educational, industrial, and other research agencies in the interest of the national defense and scientific and industrial research, by establishing the National Research Council. This council of scientists and engineers has already a fine record of achievement..

AMBROSE SWASEY.

To his first large gift, the principal of which is still intact, Mr. Swasey has now added generously ($200,000) at another psychological moment. As the great conflict seems nearer an end, there lies immediately before humanity a great era of physical reconstruction, and, vastly more, an era of spiritual advancement and elevation such as has never yet been experienced. Many of the problems of human relationships, of justice and of mercy, await the genius of the engineer for their solution, quite as much as do the tasks of construction and the development of physical resources. Let us go forward with Ambrose Swasey into the fields of opportunity. Let differences be put aside and a united, mighty effort be exerted for the advancement of the Engineering Profession and of mankind.

ALFRED D. FLINN, *Secretary*,
United Engineering Society and
Engineering Foundation.

APPEAL FOR CHILDREN OF FRENCH ENGINEERS KILLED IN THE WAR

Those familiar with the war in France at first hand know that in these last two years the weight of the suffering has fallen upon the families of the well-to-do classes; those who before the war lived in comparative ease and comfort, with every prospect of educating their children as their parents and grandparents had been. Thousands of the men in these families have been killed, "officiers d'élite," and the small pensions accorded the widows permit them only to house and feed their children

HELÈNE JOURNÈS.

and give them a common-school education. The pension for a lieutenant's widow is $245 a year; for a captain's, $345; for a colonel's $575; and so on. At present, it requires three francs a day to provide food for one person in cities, and conditions are not improving.

The American Ouvroir Funds, 681 Fifth Ave., New York City, has tried for nearly two years to have individual Americans give individual children a "bourse," or purse, as it is called, of from $150 to $250 a year, so that they may enter such educational institutions as the Lycées, the Polytechnique, Beaux Arts, St. Cyr, etc. The war relief societies of these military schools furnish photographs and histories of children under their care and on their lists.

In about eighteen months the American Ouvroir funds has sent to France over $500,000 in "adoptions," so called, from individual Americans, without any press publicity or propaganda whatever. The orphans of the St. Cyr officers were first assisted and afterward those of the other military schools.

In the Spring of 1917, General Vignal, Military Attaché at the French Embassy at Washington, suggested that the Funds should also try to help the orphans of the great French school for engineers, the Anciens Elèves de l'Ecole Polytechnique, whose families as a rule were poorer in income than many of the others, these families having been dependent solely upon the intellectual earnings of the father to support the family before his death. Therefore, they were often placed in an even more impecunious position than others. Arrangements were later made with the Société Amicale de l'Ecole Polytechnique for the Funds to be its sole representative in America for these *marrainages*, or adoptions. As now it is much harder to obtain substantial help for children than it was a year ago, before the war had come so close home to ourselves, the Funds turns to the engineers of America for help for these particular orphans. One of these children is Hélène Journès, who is here shown. She was born June 25, 1912, and is the youngest child of Fernand Henri Journès, a Captain in the Engineers, who died of wounds April, 1915, at Beauséjour (Marne). His citation in the army orders said that he was constantly seeking the most dangerous missions and directed in person the mining operations, going under a German trench to encourage the men at work and to listen at the end of the gallery to the subterranean noises coming from the enemies working. He left a widow and three children, Charles, born in 1909, Pierre, born in 1911, and Hélène.

In a recent letter, Col. Stephen Sewell, 17th Engineers Railway, A. E. F., France, says "There are many families in France impoverished by the war in which the children stand little chance of being educated and trained for the station in life for which they are fitted by birth and breeding. I grew up in the South after our Civil War and knew many families in which one generation had to go through a gruelling struggle with deterioration of individuals who, had they been educated, would have held themselves on a higher plane. There is a field where any amount of money, great or small, could be expended to advantage in helping France to maintain the natural leadership of the race."

A widow whose children have been helped writes, "In this atrocious war the widows have known all the moral tortures of the mind and soul which human beings can suffer."

Members of the Institute who can aid in the educating of children of the French engineers who so freely gave their lives for us are urged to communicate directly with the American Ouvroir Funds, 681 Fifth Ave., New York City.

WOMAN'S AUXILIARY

CENTRAL EMERGENCY COMMITTEE

Chairman, MRS. H. N. SPICER

As no further requisition will be made for knitted garments for the boys of the 27th Engineers, all completed garments and wool have been collected and returned to Mr. W. R. Ingalls, and the activities of the

Emergency Committee have ceased. Columbia Section of the A. I. M. E., Spokane, Wash., Mrs. F. Keffer, Chairman, donated 20 pairs of socks and 2 sweaters.

CENTRAL FOREIGN WAR RELIEF COMMITTEE

Chairman, MRS. H. H. KNOX

Sufficient funds have been received and transmitted to the American Fund for French Wounded to maintain one dispensary for women and children in the war zone of France, and $1400 is on hand for the establishment of a second.

At the October meeting the Secretary was instructed to send a letter to Mrs. H. H. Knox, who has been compelled, by illness, to resign her office of chairman, conveying the sympathies of the members in her illness; also a letter to Mrs. Pauline Sands Lee thanking her for her services as speaker at the various meetings held to raise funds for the dispensaries.

The Committee proposes an Engineers' afternoon, once a week, at the headquarters of the A. F. F. W., 73 Park Avenue, where women whose interests are with the mining profession might join in sewing for the dispensary, provided a sufficient number of workers can be pledged. The result of this campaign will be reported next month.

HOUSING OF LABOR AND SANITATION AT MINES IN INDIA*

The housing of labor and sanitation at mines in India are difficult problems to solve because no more than two or three castes will accept the same conditions, and conditions suitable to one coal field are not applicable to other fields. It is also necessary to consider the financial standing of the different companies. The European companies, which pay 30 per cent. and more dividends, can erect more suitable houses than the Indian companies, which are just able to keep their heads above water.

The Santhal will not live in a bucca-roofed house as a permanent dwelling, and both the Santhal and Koras have an aversion to living in a line of attached huts. They have forsaken a whole line of houses in one of which a case of sickness or death has occurred, and those houses were afterward considered unfit by all other classes of natives. The Santhals, Koras, and Douri castes will not take drinking water from a stand pipe; wells must be furnished. When well water is not available, these people will take water from the nearest pool or tank regardless of whether or not the water is stagnant. The well tops should not be completely enclosed, nor should there be a drain around the top. The ground should slope away from the well.

In the Girieih coal fields, the miners have a great objection to pucca floors; they prefer earth which is lapped, easily cleaned, and renewed. As it is customary for the miner to build his own house, the company supplying the roofing material, he takes a special interest in it, keeps it in order, and hesitates to leave it. Each house is surrounded by its own bit of land, which the inmate cultivates.

---

* Abstract from *Trans.*, Mining and Geological Institute of India, April, 1918.

PRODUCTION OF IRON ORE AND PIG IRON IN 1917

Statistics compiled by the United States Geological Survey show that the iron ore mined in the United States in 1917 reached a total of 75,288,-851 gross tons, exceeding the former record output of 1916 by 121,179 tons. The shipments from the mines in 1917 were 75, 573,181 gross tons, valued at $238,260,333, a decrease in quantity of 2,297,372 tons, or 2.95 per cent., and an increase in value of $56,358,056, or 30.98 per cent., over the shipments in 1916. The average value per ton at the mines for all grades of ore in 1917 was $3.15 as against $2.34 in 1916. Stocks of iron ore at mines, mainly in Minnesota and Michigan, amounted at the close of 1917 to 10,628,908 gross tons, compared with 10,876,352 gross tons in 1916.

The quantity of pig iron, exclusive of ferro-alloys, sold or used in 1917, according to reports of producers to the United States Geological Survey, amounted to 38,612,546 gross tons, valued at $1,053,785,975, compared with 39,126,324 gross tons, valued at $663,478,118 in 1916, a decrease of 1.32 per cent. in quantity and an increase of 59 per cent. in value. The average price per ton at furnaces in 1917, as reported to the Survey, was $27.29, compared with $16.96 in 1916, an increase of 61 per cent. The production of pig iron, including ferro-alloys, was 38,647,397 gross tons in 1917, compared with 39,434,797 gross tons in 1916, a decrease of 4.5 per cent., according to figures published by the American Iron and Steel Institute, March 18, 1918.

CONSULS NEEDED FOR OUR MERCHANT MARINE

Our merchant marine is rapidly outgrowing our consular service, according to Edward N. Hurley, Chairman of the United States Shipping Board, who urges that steps be taken immediately to provide facilities abroad for handling the millions of tons of shipping which will be afloat under the American flag in peaceful trade when the war is over. When peace is restored and our present tonnage is scattered over world trade routes, the consular service will be inadequate to handle our ships. Besides, it will have to work against the handicaps of obsolete shipping regulations and, in many cases, lack of experience. There are nearly 100 pages in the United States consular regulations dealing with shipping matters. Many of these regulations are based on old treaties and many of them are obsolete. There are also differences between treaties with various countries. Our consuls often lack authority to handle matters involving the interests of our sailors and shipowners. Before we can operate a modern merchant marine we must revise, standardize, and simplify this whole mass of regulations and bring them up to the efficiency of other nations' practice.

GOVERNMENT CONTROL OF MINERALS

Congress has authorized the President to control the supply and distribution of the following: Antimony, arsenic, ball clay, bismuth, bromine, cerium, chalk, chromium, cobalt, corundum, emery, fluorspar, ferrosilicon, fullers' earth, graphite, grinding pebbles, iridium, kaolin, magnesite, manganese, mercury, mica, molybdenum, osmium, sodium, platinum, palladium, paper clay, phosphorus, potassium, pyrites, radium,

sulphur, thorium, tin, titanium, tungsten, uranium, vanadium, and zirconium. It appropriated fifty thousand dollars toward the expense of the organization necessary to carry out its provision, and fifty million dollars as a revolving fund. This control terminates two years after the end of the war.

RAILROAD CUT-OFF SPEEDS UP TRANSPORT TO FRONT

By completing a double-track railroad cut-off, involving a large volume of cut and fill, in addition to a half-mile bridge spanning an important French river, engineers in the zone of the Services of Supply have opened up a route by means of which hours of valuable time are being saved in transporting men and materials to combat areas. Its most valuable feature is that it provides a means for by-passing a certain city where several French railroad lines converge and where, consequently, congestion of traffic has been responsible for delayed train movements. To avoid a double-track turnout, which would have involved a cross-over cutting one of the French tracks, the two track connections of the cut-off are taken off from opposite sides of the French right-of-way. This involved running one of the new lines of the cut-off out from the main line track on a fill to a point where it could be brought back and over the French track on a steel girder bridge. Beyond this bridge the two tracks of the cut-off converge and straighten out in the standard type of double-track construction.

The new cut-off is about 5¾ mi. (9 km.) long and has required 160,000 cu. yd. of cut (122,329 cu. m.) and 414,000 cu. yd. (316,527 cu. m.) of fill. In the biggest continuous fill a yardage of 180,000 has been placed, the road-bed in this section being about 40 ft. (12 m.) above the original ground surface. The bridge portion of the cut-off, 2190 ft. (667.5 m.) long, is made up of ninety-nine 14-ft. (4.3 m.) timber spans and sixteen 50-ft. (15.3 m.) steel girder spans. This is the longest bridge which engineers of the American Expeditionary Forces have built in France. The timber spans are supported by pile trestle bents, while the longer steel girders rest on clusters of 43 piles. Two pile drivers of the steam-hammer type worked from each end of the bridge toward the center of the river, while a drop hammer worked westward from the shore end. In this structure nearly two thousand piles 50 ft. or so in length had to be driven.

DIED IN SERVICE

Bailey, Lewis Newton, Master Engineer, Senior Grade, 4th Regiment, U. S. Engineers, Headquarters Company, died of pneumonia at Camp Merritt, N. J., on April 30, 1918.

Baird, Louis, Lieut., Royal Field Artillery, British Army, died on the battlefield in 1915.

Ballamy, John H., Capt., 103d Engineers, killed in action near Fismes, Aug. 9, 1918.

Bowles, Martin F., 2d Lieut., Co. B, 355th Infantry, killed in action, Sept. 3, 1918.

Burt, Andrew, died in active service, 1916.

Cobeldick, William Morley, Royal Engineers, died from gas poisoning on Oct. 7, 1915.

Dougall, Ralph, 4th University Co., Princess Patricia Regiment, killed in action early in the war.

Evans, Alfred Winter, Lieut.-Col., New Zealand Rifle Brigade, D. S. O., D. C. M., killed in action on Oct. 12, 1917.

Gordy, Sheppard B., died in service, Oct. 9, 1918.

Gorman, Thomas C., Lieut., Canadian Engineers, killed in France, Mar. 18, 1918.

Hague, William, 1st Lieut., Engineer Officers' Reserve Corps, died in active service, Jan. 1, 1918.

Hall, Willian T., Capt., Royal Flying Corps, killed in action, May 19, 1917.

Heine, Bernhardt E., Lieut., Aviation Service, died from accident at Fort Sill, Okla., Aug. 10, 1918.

Irving, John Duer, Capt., 11th Engineers, A. E. F., died July 26, 1918, while on active service in France.

Perry, Edward H., 1st Lieut., Co. D, 6th Regiment Engineers, U. S. Expeditionary Forces, France, killed in action on March 30, 1918.

Pretyman, Frank Remington, 2d Lieut., Royal Engineers, killed in action on June 17, 1916.

Reece, Fred. B., Capt., Royal Engineers, B. E. F., 232d Army Troops Co., killed in action.

Ringlund, Soren, Medical Department, Fort Logan, Colo., died suddenly in camp on July 24, 1918.

Roper, George, Jr., Lieut., Royal Flying Corps, killed in aeroplane accident in England on May 25, 1918.

NEWS FROM MEMBERS IN SERVICE

Thomas H. Beddall, so we are informed by Major J. B. Carlock, has been promoted and is now Adjutant of the 1st Battalion, 1st Gas Regiment. He was awarded, last summer, the Croix de Guerre.

R. A. Bull. See letter in *Proceedings* of Milwaukee Meeting.

Captain Stanley C. Bullock's record since entering the service is given as follows in a letter recently received from Mrs. Bullock:

Resigned position of mine manager in Chile in November, 1915, to return to England to obtain commission in Royal Engineers.

Joined Officers' Training Corps, Dec. 20, 1915.

Commission gazetted, Jan. 27, 1916, 2d Lieut., R. E.

Landed in France, Feb. 6, 1916. Posted to 179th Tunnelling Co., R. E. Took part in following battles: Somme, 1916; Ypres, 1917; Arras, 1917; Somme, March and July, 1917; Messines, 1917.

Gazetted: Acting Captain, July 11, 1916; Temp.-Lieutenant, Oct. 26, 1916; Captain, Sept. 29, 1918.

Awarded Military Cross, Jan. 1, 1918, for conspicuous bravery and devotion to duty under a heavy enemy gas bombardment, when, by his example and perseverance in spite of every difficulty and obstacle, mining work was successfully completed which was vital for the success of the operations. The Cross was presented to Capt. Bullock by the King, on Sept. 25, 1918.

First Lieut. J. J. Cadot, in a letter sent to Mr. H. W. Hardinge from France, says he has been at the "Front." He also mentions that the Boche "is a *good sprinter.*"

J. B. Carlock has been commissioned a Major of the 2d Battalion, 1st Gas Regiment, and has been awarded the Croix de Guerre.

Harlowe Hardinge, in a letter to his father, says that he has been advanced from 1st Lieutenant to Captain, in the Signal Corps. During the course of his work as a Radio Signal Officer, he was sent to England, and upon his return to France, was made director of his particular division.

Second Lieut. William J. Hill, in a very interesting letter, gives us the following information:

At the present writing, I am assigned and attached for duty with the Field Artillery Central Officers' Training School at Louisville, Ky., as an instructor in Field Artillery of Officers in the Making. In the first place, the Candidates, as the students are called, come from different branches of the service and from all walks of life. In few words, this school is one great big melting pot, including among its students some well-known big men of the country.

Upon entering the school, the candidate is placed in what is known as the Observation Batteries. Here he gets his first taste of discipline if he is from civilian life; and a taste such as he never realized before if he is from some arm of the service. He is disciplined from morning until he goes to bed at night. Besides the discipline, he is taught military courtesy, dismounted drill, mathematics, and given plenty of exercise to fit him physically for the more strenuous training he will receive when transferred to a training battery. While in the observation battery, the man is sized up by capable officers as to his ability to make a good field artillery officer. As soon as he shows he is right, he is sent to the training battery; and he is given one month, if need be, to show that he has the necessary requisites.

The course in the training batteries requires twelve weeks to complete, and during this time men work as they never worked before in their lives. Immediately the work consists of field artillery, and for five days a week the candidate gets up at Reveille at 5:30 A. M. and attends classes and drills until Recall at 4:30 P.M., having one hour at noon for dinner. The other work of the day consists of two hours study in the evening from 7:00 to 9:00 P.M. To give you some idea of the large curriculum of subjects to be covered, I shall mention some of them: Administration, Anti-gas, Care and Training of Horses, Driving and Riding, Communication, Gonduct of Fire, Gunnery, Fire Discipline, Material, Motors and Tractors, Reconnaissance, Topography and Artillery Boards, and Physical Training. Certain hours each day are spent on the different subjects, and assignments each night for study cover the lessons for the following day. Then as Saturday comes around, there are examinations on the different subjects covered during the week.

From Saturday noon until Sunday evening, the candidate is on his own unless he happens to be one of the luckless men who are put on guard duty or some fatigue party. But even though the men are allowed their week ends in Louisville, they are under the constant vigilance of their instructors. In order to keep them alert and on their toes continually, each man is issued a small card with his name and battery. This card is known as a Conduct Card, and for the least infraction of rules and regulations of military courtesy or conduct of a soldier the card can be taken up by an officer and the candidate returned to camp immediately. The card is then turned into Headquarters by the officer who took it up,

with the reasons written on it. The candidate, in order to regain possession of his card, must explain his actions before a board of officers.

At the end of the twelve weeks, the candidates have a firm foundation in the rudiments of field artillery; and those who have completed their work satisfactorily are given their commissions and assigned to regiments all over the country. Then their work begins in training the great armies which we are sending to France; and in course of time they get their big chance at wiping the Hun off of the map.

Just a few words before closing regarding the officers who are instructing in this great school. Their day's work begins with the candidates, but you will find them busy at their desks in their quarters sometime long after the candidates are in bed, figuring out how to explain a certain piece of mechanism or problem in firing data so the student will grasp it most easily the next day. In truth, their work is never completed. And we are all aching for the chance to go "Over There" and there is a persistent rumor around that we are going to get it.

Major W. Waters Van Ness of the Royal Engineers has been twice mentioned in despatches by the Commander in Chief for work during the Battle of the Somme and the Battle of Pashendale Ridge.

ADDITIONAL LIST OF MEMBERS OF THE INSTITUTE IN MILITARY SERVICE

(The following list contains the names of those members of the Institute of whose connection with military service we have only recently become acquainted; it also includes the names of a few who have recently been promoted or transferred, indicated by a *. A complete list was published in the Year Book, issued as a supplement of the *Bulletin* for March, 1918.)

ANDERSON, AMIL A., Co. A, 309th Regiment Engineers, 84th Div., American E. F., Care Postmaster, New York.

ARMSTRONG, HAROLD K., Pilot, Naval Aviation, U. S. Naval Air Station, Miami, Fla.

BASSETT, ARTHUR F., Co. 6, E. O. T. S., Camp Humphreys, Va.

BEDDALL, THOMAS H., Adjutant, 1st Battalion, 1st Gas Regiment, American E. F.

BERNARD, CLINTON P., Candidate, 12th Observation Battery, F. A. C. O. T. S., Camp Taylor, Ky.

BROOKE, LIONEL, 50th Co., 13th Battalion, 5th Replacement Engineers, Camp Gordon, Ga.

BROWNING, EDWARD, Corp., 1st Regiment Engineers, Co. D, American E. F.

BUGBEE, EDWARD E., S. A. T. C. Headquarters, Raleigh N. C.

BUTTERFIELD, G. BRUCE, Co. C, 605th Engineers, American E. F.

CADOT, J. J., 1st Lieut., U. S. Air Service, American E. F., Care Postmaster, New York.

CARLOCK, J. B., Major, 2d Battalion, 1st Gas Regiment, American E. F., France.

CARPENTER, M. E., 429th Engineers, Fort Sill, Okla.

CLAGHORN, C. R., Lieut., U. S. Naval Reserve Force.

CLAGHORN, JAMES L., Lieut., Aviation Section, Signal Corps, U. S. Army, Gerstner Field, La.

CLARK, GEORGE B., Capt., Engineers, Camp Funston, Kans.

CLARKE, ALEXANDER FIELDER, U. S. Naval Aviation Service.

CORBY, HARRY G., 1st Lieut., Com. Co. D, 109th Supply Train, American E. F., France, via New York City.

CRISPELL, C. W., Specification Section, Bureau of Aircraft Production (formerly Signal Corps), Dayton, Ohio.

DAVY, WILLIAM M., Ensign, Naval Aviation Detachment, Mass. Institute of Technology, Cambridge, Mass.

DECAMP, W. V., Lieut., 428th Engineers, Camp Cody, N. M.

DICK-CLELAND, A. F., Major, 170th Co., Royal Engineers, British E. F.

ERDOFY, MAXWELL E., 2d Lieut., 602d Engineers, Co. C, American E. F.

GARRISON, MURRAY E., Flying Cadet, 5th Cadet Squadron, Ellington Field, Houston, Tex.

GAUTHIER, CHARLES B., United States Military Service.

GOODALE, STEPHEN L., Capt., Ordnance U. S. A., Bureau of Mines Bldg., Pittsburgh, Pa.

GREENWOOD, C. L., Lieut., Aero Squadron, Barracks 52, Ellington Field, Houston, Tex.

GRIMES, JOHN A., 1st Lieut., Interpretation and Reports Section, Ordnance Dept., Washington, D. C.

HARDINGE, HARLOWE, Capt., Signal Corps, U. S. R.

HARTLEY, BURTON, Capt., 45th Artillery, C. A. C., 37th Brigade, C. A. C., American E. F.

HAYES, F. H., Major, Army General Staff College, A. P. O. 714, American E. F.

HILL, WILLIAM J., 2d Lieut., 11th Training Battery, F. A. C. O. T. S., Camp Zachary Taylor, Ky.

HOOK, J. S., Lieut., Headquarters First Unit, Wilbur Wright Field, Dayton, O.

HOWELL, JESSE V., 16th Training Battery, F. A. C. O. T. S., Camp Taylor, Ky.

INGLE, HUGH C., 472d Engineers, Care Carter's Villa, Red Bank, N. J.

JOHNS, A. L., 434th Engineers, Camp Kearny, Cal.

KEYES, HARMON E., Artillery Branch, U. S. Army.

KING, ROWLAND, 1st Lieut., Engineers, Camp Headquarters, Camp A. A. Humphreys, Va.

KITSON, H. W., Ensign, U. S. S. "Delaware," U. S. Navy, Care Postmaster, New York.

KOCH, HUGO E., Pvt., Enlisted Ordnance Corps, U. S. A., Watertown Arsenal, Watertown, N. Y.

LAROQUE, F., Cadet, Royal Air Force.

LASNER, DAVID, Chemical Warfare Section, U. S. A., Edgewood Arsenal, Md.

LATHROP, LLOYD J., Lieut., 529th Engineers, American E. F.

LEVY, MILTON M., 1st Lieut., 315th Engineers, Camp Travis, Tex.

LEWIS, C. R., Candidate, Co. D, Candidates' School, Fort Monroe, Va.

LINDHOLM, MILTON S., Lieut., Co. C, 109th Engineers, American E. F.

LUTTS, CARLTON G., Met., Boston Navy Yard, Boston, Mass.

McCARTHY, EDWARD PROSPER, Capt., Co. 2, E. O. T. S., Camp Humphreys, Va.

MACY, G. D., 33d Training Battery, F. A. C. O. T. S., Camp Taylor, Ky.

MAHONEY, JOHN J., Pvt., Co. D, 39th Machine Gun Battalion, Camp Lewis, Wash.

MARBLE, RALPH N., JR., Lieut. Comdr., U. S. Navy, The Marlborough, 917 18th St., N. W., Washington, D. C.

MARSHALL, EMORY M., Lieut., Ordnance Dept., American E. F., Care Postmaster, New York.

MARTIN, CURTIS FRANK, American E. F., France.

MATTHIAS, MAXIMILIAN P., Lieut., Ordnance Dept., U. S. A., 194 Nesmith St., Lowell, Mass.

MILLER, DONALD G., Major, 4th Engineers Training Regiment, Camp Humphreys, Va.

MILLER, WALTER BYRON, Capt., Engineers, U. S. Army.

MOSES, PERCIVAL SNEED, Lieut., Quartermasters Dept., Embarkation Office, American E. F.

MUNROE, CHARLES E., Chairman, Committee on Explosives Investigation, National Research Council, Washington, D. C.

MURPHY, WILLIAM J., 2d Lieut., 5th Prov. Battalion, Fort Benj. Harrison, Ind.

NEGRU, JACQUES S., Spr. 2504000, 9th Battalion, Canadian R. R. Troops, Canadian E. F.

OTTO, J. F., 38th Co., 10th Battalion, Camp Upton, N. Y.

OVERPECK, ARELI C., Capt., Engineers R. C.

PARSONS, GEORGE H., Chemical Warfare Section, Gas Defense Div., Astoria, L. I.

POWELL, D. A., 2d Lieut., Coast Artillery Corps, U. S. A., 62 South, Ft. Monroe, Va.

PRICE, JOHN M., 2d Lieut., A. S., Military Aeronautics, Ft. Sill, Okla.

SKIRM, JOSEPH G., U. S. Army Service.

SMITH, FRANK A., Corp., 2d Batt. Det., C. C. W. S., Edgewood, Md.

STANLEY, JAMES, Major, Army Service Corps, A. P. O., S. 7, British E. F., France.

STEIDLE, EDWARD, Capt., Co. D, 30th Engineers, American E. F., Care Postmaster, New York.

STEWART, JOHN S., Co. 1A, E. O. T. S., Camp Humphreys, Va.

STEWART, M. B., 2d Lieut., F. A., U. S. Army.

TEAS, PIERSON, 2d Lieut., U. S. A., Aberdeen Proving Grounds, Md.

VAN NESS, W. WATERS, Major, Royal Engineers, O. C. 238, Light Regimental Forward Co., R. E., British E. F., France.

WALTER, RAYMOND A., Capt., C. O. Co. B, 70th Engineers, Ft. Douglas, Utah.

WIEGAND, AUGUST JOHN, United States Army.

WILLETS, ROBERT H., 1st Lieut., General Engineer Depot, Munitions Bldg., Room 2830, 19th & B Sts. N. W., Washington, D. C.

WILLIAMS, EDWARD I., Lieut., 65 South, Fort Monroe, Va.

WILLIAMS, P. T., Lieut., 6th Reserve Battalion, Royal Engineers, Irvine.

WISE, ALFRED L., Ensign, U. S. N. R. F., Reserve Officers' Quarters A, Room 432, U. S. Naval Academy, Annapolis, Md.

WISSER, EDWARD HOLLISTER, 2d Lieut., 319th Engineers, American E. F., Care Postmaster, New York.

WOLFARD, O. L., Lieut. Comdr., U. S. S. "New Mexico," U. S. Navy, Care Postmaster, New York.

WRIGHT, W. RYER, 1st Lieut., Ordnance Dept., Inspection Div., Explosives Section, New York.

YARDLEY, JOHN L. McK., Capt., Co. B, Engineers Tr. Regiment, Camp Humphreys, Va.

PERSONAL

The following is an incomplete list of members and guests who called at Institute headquarters during the period Oct. 10, 1918 to Nov. 10, 1918.

J. Carson Adkerson, Virginia.
Andrew B. Armstrong, Connecticut.
Courtenay DeKalb, San Francisco.
Clifford G. Dennis, San Francisco.
Rudolph Emmel, Boston, Mass.
Emil Gathmann, Baltimore, Md.
Ernest S. Geary, Denver, Colo.
W. E. Hopper, Washington, D. C.
W. Spencer Hutchinson, Boston, Mass.
E. W. Kohl, Jr., Philadelphia, Pa.
E. C. Nighman, Butte, Mont.
George H. Parsons, Hayden, Ariz.
W. E. Pomeroy, New York.
Ezra C. Rider, Bisbee, Ariz.
H. W. Seaman, Chicago, Ill.
William Allen Smith, Northampton.
R. K. Stockwell, Salt Lake City, Utah.
W. G. Swart, Duluth, Minn.
Kirby Thomas, New York.
Warren D. Thompson, Harvard Club.
H. Vincent Wallace, Los Angeles, Cal.

Paul T. Benson, formerly with the Tacoma smelter, has resigned his position there to accept one with the Great Metals Mining and Milling Co. at Nespelem, Wash.

Prof. Edward E. Bugbee, of the Mining Department of the Massachusetts Institute of Technology, has been granted a leave of absence to accept the position of Assistant Director of Education for the S.A.T.C. of five southern states with headquarters at Raleigh, N. C.

A. R. Campbell is now assistant to the secretary of the Lead Producers Committee for War Service, with offices at 61 Broadway, New York City.

Walter N. Crafts is now assistant general superintendent of the British Forgings Ltd. at Toronto, Canada.

George Crerar is now in charge of the Dayton Placer Recovery Corporation at Dayton, Nev.

Erle V. Daveler has left the Alaska Gastineau Mining Co. to become mill superintendent of the Butte & Superior Mining Co. at Butte, Mont.

Francis N. Flynn is now located at Newark, N. J., as assistant general superintendent of the Balbach Smelting & Refining Co.

Walter E. Gaby has opened an office at 208 Douglas Ave., Salt Lake City, where he will engage in engineering geological work. For the past year, Mr. Gaby has been connected with the Nevada-Douglas Cons. Copper Co. in the Yerington Dist., and is still retained by that company in a consulting capacity.

C. J. Hall has resigned his position with the Garfield Smelting Co. of Garfield, Utah, and is now with the Copper Queen Reduction Works at Douglas, Ariz.

W. H. Harris has accepted the position of superintendent of the Bush Mine, Stewart, B. C.

E. C. Hickman, metallurgist, formerly with the American Smelting & Refining Co. at Murray, Utah, is now assistant superintendent with the St. Joseph Lead Co. at Herculaneum, Mo.

Clemence W. Hippard is at present on the staff of the University of Illinois, Urbana, Ill., as graduate research assistant, Engineering Experiment Station, Department of Mining, with offices at 211 Transportation Building.

Brian H. Hooker is now connected with the Commonwealth Bureau of Census and Statistics with offices at Rialto, Collins Street, Melbourne, Australia.

Albert J. Houle has severed his connection as Professor of Metallurgy with the Michigan College of Mines at Houghton, Mich.

Olaf P. Jenkins has changed his position from assistant professor of economic geology at the State College of Washington to geologist of the Arizona Bureau of Mines, University of Arizona, Tucson, Ariz.

Edward K. Judd, for the past year managing editor for this Institute, has resigned to take a position in the operating department of the American Metal Co., 61 Broadway, New York.

Frank A. Kennedy has resigned as general superintendent of Butler Bros. mine, Mesabi Iron Range, to go into consulting practice, with offices at 1006 Alworth Building, Duluth, Minn.

Oscar Lachmund, having resigned his position as general manager of the Canada Copper Corporation, Ltd., will engage in private engineering practice at Spokane, Wash., in Room 822 of the Paulsen Building.

J. B. Lain, formerly at Columbia University, New York, is now at Latouche, Alaska, as mill superintendent of the Kennecott Copper Co.

Willis Lawrence is now manager of the Oat Hill quicksilver mines, Middletown, Lake County, Cal.

J. T. Morris, superintendent Stotesbury operation of the E. E. White Coal Co., Stotesbury, W. Va., has resigned his position to accept the general managership of the Pemberton Coal & Coke Co., with headquarters at Affinity, W. Va., effective October 15.

H. A. Morrison has recently taken a position at the Liberty Shipyard in Alameda; his new address is 5237 College Avenue, Oakland, Cal.

Arthur B. Parson has accepted a position with the Butte & Superior Mining Co., Butte, Mont.

O. F. Riser is now assistant superintendent of mills with the Chino Copper Co., at Hurley, New Mex.

Andrew Rocca, Jr., is now vice-president and superintendent of the Western Mercury Co., Inc.

William S. Sirdevan is efficiency engineer for the United Verde Copper Co., Jerome, Ariz.

R. K. Stockwell is general sales manager with the Robins Conveying Belt Co. at their New York office in the Park Row Building.

Ernest A. Strout recently became manager of the Le Fe Mining Co., Ltd., Guadalupe, Zacatecas, Mex.

W. M. Weigel is superintendent of the smelting department of the Missouri Cobalt Co., Fredericktown, Mo.

Albert G. Wolf is field engineer with the Mason Valley Mines Co. at Thompson, Nev., having resigned his position with the Mary Murphy Gold Mining Co. at Romley, Colo.

ENGINEERS AVAILABLE

(Under this heading will be published notes sent to the Secretary of the Institute by members or other persons introduced by members.)

No. 488.—Mining engineer, member, technical graduate, married, age 38, desires position of superintendent or assistant superintendent. Has had 15 years' practical experience as miner, millman, machinist, surveyor, engineer, foreman, and superintendent in the West, Southwest, and Mexico. Speaks Spanish. Now employed as superintendent of copper property in Southwest. Can give the best of references. Minimum salary $250. Available after Sept. 1.

No. 495.—Member, age 36, married, technical, 10 years' all round

experience operation and examination gold, silver, copper, manganese, in United States, Mexico, South America. At present in States. Desires change of position.

No. 502.—Member, mining engineer, age 30 years. Married, 10 years' experience in coal mines as chainman, transitman, superintendent, and chief engineer. Now employed as chief engineer of large coal company producing 3,000,000 tons coal per year. Desires to get located in West or South. Available Jan. 1, 1919.

No. 503.—Mining engineer and metallurgist, member, age 36 years. Fifteen years' experience in United States, Mexico, Canada, Alaska, Central and South America. Ten years in executive capacities in management of small operations, mining, milling and smelting copper, lead, silver and gold ores. Design and construction mine and mill buildings. Speaks Spanish.

No. 504.—Member, technical graduate, draft exempt, who has been employed as research chemist in cyanidation and flotation for past 5 years desires position with large company as metallurgist or assistant mill superintendent. Especially experienced in flotation of gold and silver ores, but am also familiar with flotation of lead-zinc ores. Foreign service not desired. Will be at liberty after Dec. 1, 1918.

No. 505.—Member, graduate mining engineer, with 8 years' practical experience, including experience as superintendent. Desires position as engineer, foreman or superintendent of mine.

No. 506.—Successful young mining geologist desires connection with large or several small concerns in the West. Present headquarters Salt Lake, but favors Southwest. Columbia graduate scholar. Married.

No. 507.—Engineer and geologist, member, age 35 years, married, experience in geologic survey, reconnaissance and mapping work with special qualification for micro-petrographic research, desires employment with mining enterprise offering opportunity for advancement; at present employed partly in other engineering work, wishes change to mining field exclusively.

No. 508.—Member, American, single, technical education, 12 years' experience in Mexico and Central America in gold and silver mining, in practically all capacities; last four years superintendent of producer employing 250 men. Familiar with construction and difficult transportation conditions. Can get results with native labor. Available after the war.

POSITIONS VACANT

No. 349.—A Canadian university wishes to engage a man to teach non-ferrous metallurgy and ore-dressing as well as to direct research work. The instruction work covers 7 months but the research work is continued throughout the year. To a suitable man the rank of professor will be granted. Applicants are requested to state education, experience, salary desired and any other particulars that might assist in selecting a man for this position.

No. 354.—Wanted, for Northern Nigeria, one chief and two assistant mining engineers, competent surveyors, with good knowledge of alluvial tin mining and dressing of tin concentrate. Preferably with previous Nigerian experience, and exempted or able to secure passport. Apply in writing, stating qualifications, experience and salary required.

No. 355.—Wanted: Superintendent for tungsten property in Arizona. Man having had experience in handling Mexican labor preferred. Salary $2500, with dwelling house partly furnished.

No. 356.—Wanted: Mining engineer for the staff of an organization of consulting engineers working in fire prevention and accident prevention. Metal and coal experience necessary. Broad vision and the ability to meet big men and to carry conviction are essential. If you have these and the other qualifications necessary to professional work of the very best type—if you think that you are the man we need—then write without delay.

No. 357.—Wanted: Surveyor and draftsman at a salary of $150 per month; room and light furnished. Climate healthful. Situation about 70 miles northwest of Guadalajara, Jal., Mexico.

No. 358.—Wanted: Services of a good mine transitman or engineer. Prefer applicant to be in neighborhood of 30 years old; well experienced in underground surveys, good draftsman, and with sufficient personality to get results from the men. Application should contain age, nationality, experience, especially underground, names of various coal companies employed by or in, specimen of drafting or lettering.

No. 359.—Large mining concern has a position in the engineering department. At present work will be largely mine surveying and mapping, but with some miscellaneous engineering work. Later on work will lead to a better position, taking up all branches of mining engineering, including mining, concentration and geology. Splendid chance for advancement. Desire an especially capable man, so would want applicant to come on trial for two or three months. Suitable houses, ready for occupancy, will be furnished to married men; for single men there is an employees' club house—room and board for $1 per day.

No. 360.—Man to assist in investigation of partly developed mineral properties in Brazil. Must have had some experience in mine sampling; mine examination experience not absolutely essential. Should be able to speak Spanish; knowledge of Portuguese preferable.

FORTHCOMING MEETINGS OF SOCIETIES

Organization	Place	Date
		1918
American Society of Mechanical Engineers	New York, N. Y.	Dec. 3–6
Society for Promotion of Engineering Education, with British Educational Mission	Cambridge, Mass.	Dec. 6–7
Geological Society of America	Boston, Mass.	Dec. 28–31
American Association for the Advancement of Science	Boston, Mass.	Dec. 27–Jan. 2.
		1919
International Mining Convention (Auspices, Vancouver Chamber of Mines)	Vancouver, B. C.	Jan. 8–10
American Society of Civil Engineers	New York, N. Y.	Jan. 15–16
American Wood Preservers Association	St. Louis, Mo.	Jan. 28–30
American Society of Heating and Ventilating Engineers	New York, N. Y.	Jan. 28–30
American Institute of Mining Engineers	New York, N. Y.	Feb. 17–20
New England Association of Gas Engineers	Boston, Mass.	Feb. 19
American Railway Engineering Association	Chicago, Ill.	Mch. 18–20

LIBRARY

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF MINING ENGINEERS
UNITED ENGINEERING SOCIETY
HARRISON W. CRAVER, DIRECTOR

The library of the above-named Societies is open from 9 A. M. to 10 P. M. except on holidays. It contains about 70,000 volumes and 90,000 pamphlets, including sets of technical periodicals and publications of scientific and technical societies.

Members of the Institute, with few exceptions, are forced to spend a portion of their time in localities isolated from sources of information. To these the Library, through its Library Service Bureau, can render valuable service through correspondence; letters requesting information will receive especial attention. The Library is prepared to furnish references and photographic copies of articles on mining and metallurgical subjects; to determine the existence of mining maps, and to furnish general information on the geology and mineral resources of all countries.

All communications should be made as definite as possible so that the information received may be what is desired and not include collateral matter which may not be of interest. The time spent in searching for such collateral matter will be saved, and the information will be sent more promptly and in more usable shape.

Library Accessions

AMERICAN SOCIETY FOR TESTING MATERIALS. Membership List, Charter and By-Laws, etc. 1918. Philadelphia, 1918.

BROKEN HILL PROPRIETARY COMPANY, LTD. Reports and Statements of Account for half-year ending May 31, 1918. Victoria, 1918. (Gift of Company.)

BROKEN HILL SOUTH SILVER MINING COMPANY. Reports, Statements of Accounts, etc. for half-year ended June 30, 1918. Melbourne, 1918. (Gift of Company.)

CENSUS OF VIRGIN ISLANDS OF UNITED STATES. 1917. Washington, 1918. (Gift of U. S. Bureau of Census.)

CHILEAN MINING CODE. January 1, 1889. By Charles E. M. Michels. Santiago de Chile, 1914. (Gift of Author.)

ENGINEERS' CLUB OF PHILADELPHIA DIRECTORY, 1918. Philadelphia, 1918. (Gift of Club.)

ENGINEERING SOCIETY OF CHINA. Proceedings. Vols. 9–14, 1909–15. Shanghai, 1911–15.

FARES AND FREIGHT RATES. What of the aftermath of Government control of railroads. By H. W. Seaman. (*Bulletin* No. 46, City National Bank, Clinton, Iowa.) 1918. (Gift of City National Bank.)

FUEL SAVING IN POWER PLANTS. (*Bulletin* No. 1, Advisory Engineering Committee to the Massachusetts Fuel Administrator.) Boston, 1918. (Gift of A. S. M. E.)

GREAT BRITAIN. Department of Scientific and Industrial Research. First Report of Mine Rescue Apparatus Research Committee. London, 1918.

———, Report of Committee of Privy Council. 1917–18. London, 1918. (Gift of Department of Scientific and Industrial Research.)

INTERNATIONAL MILITARY DIGEST. Annual, 1917. New York, 1918.

IRON & STEEL INSTITUTE. Journal, vol. 97, No. 1, 1918. London, 1918.

LA DISTILLATION FRACTIONNÉE ET LA RECTIFICATION. By Charles Mariller. Paris, 1917.

MERCHANTS' ASSOCIATION OF NEW YORK. I. Opposing Government Ownership and Operation of Public Utilities; II. Advocating Exclusive Regulation of all

Railroads by Federal Government. Nov., 1916. (Gift of Merchants' Association of New York.)

MINERALS AND METALS FOR WAR PURPOSES. Hearing before Committee on mines and mining, United States Senate, 65th Congress, Second Session. Washington, 1918.

MINING AND GEOLOGICAL INSTITUTE OF INDIA. Member List, 1918.

MINING OPERATIONS IN PROVINCE OF QUEBEC, 1917. Quebec, 1918.

MYSORE. Chief Inspector of Mines. Report. 1915–16, 1916–17. Bangalore, 1918.

NATIONAL LIME MANUFACTURERS' ASSOCIATION. Hydrated Lime Bureau.

———, Concrete Evidence. (*Bulletin* A-7.)

———, Hydrated Lime in Concrete. (*Bulletin* A-8.)

———, Hydrated Lime in Concrete Roads, Field Test Results. (*Bulletin* K-2.)

NEW ZEALAND INSTITUTE. Transactions and Proceedings. Vol. L. Wellington, 1918.

OPERATIONS MINIERES DANS LA PROVINCE DE QUEBEC, 1917. Quebec, 1918.

PENNSYLVANIA. Department of Mines. Report. 1916. Pt. I—Anthracite. Harrisburg, 1917.

PORTLAND CEMENT ASSOCIATION. Magazine list, September, 1918. (Gift of Association.)

PUBLIC UTILITIES REPORTS. Digest, 1917. Rochester, 1918.

SVENSKA TEKNOLOGFÖRENINGEN. Ledamotsförteckning. Juni, 1918. Stockholm, 1918.

TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMÉRIQUES DE CHIMIE, DE PHYSIQUE ET DE TECHNOLOGIE. Rapport général presenté au nom de la Commission Permanente du Comité International pour l' année, 1917. Paris, 1918. (Gift of Association Internationale des Academies.)

TECHNO-CHEMICAL RECEIPT BOOK. By Wm. T. Brannt and Wm. H. Wahl. Philadelphia, 1917. (Gift of Samuel Wein.)

U. S. DEPARTMENT OF THE INTERIOR. Reports. 1917. Vols. 1–2. Washington, 1918. (Gift of Department of the Interior.)

VOCATIONAL SCHOOLS FOR WORKERS IN COAL AND METAL MINES. Washington, 1918. (Gift of Federal Board for Vocational Education.)

WHAT INDUSTRY OWES TO CHEMICAL SCIENCE. By Richard B. Pilcher and Frank Butler-Jones. London, 1918.

YEARBOOK OF SCIENTIFIC AND LEARNED SOCIETIES OF GREAT BRITAIN AND IRELAND. Compiled from Official Sources. London, 1917.

Book Notices

Unless otherwise specified, books in this list have been presented by the publishers. The Institute does not assume responsibility for any statements made; these are taken from the preface or the text of the book, unless otherwise noted.

AMERICAN ASSOCIATION OF ENGINEERS DIRECTORY. Containing Lists of Members Arranged Alphabetically, Geographically, and According to Professional Work. Corrected to July 1, 1918. Chic., American Association of Engineers (copyrighted, 1918). 190 pp., 2 diag., 1 map, 9 × 6 in., cloth, $2.

THE ARBITRAL DETERMINATION OF RAILWAY WAGES. By J. Noble Stockett, Jr. Boston and N. Y., Houghton Mifflin Co., 1918. 198 pp., 8 × 5 in., cloth, $1.50.

CONTENTS: Standardization, The Living Wage, The Increased Cost of Living, Increased Productive Efficiency, Principles Governing the Arbitral Determination of Wages.

This volume of the Hart, Schaffner, & Marx Prize Essays is a study of the principles of wage determination and of wage increase advanced by the employees and employers in the course of arbitration proceedings, with a view to ascertaining some fundamental principles which may serve as the basis of a fair and reasonable wage or of a just principle of wage increase. The arbitration proceedings examined number sixty-five and include those settled under the provisions of the Erdman Act and the Newlands Act, the railway cases under the Industrial Disputes Investigation Act, the Eastern Engineers' Arbitration of 1912 and the Western Engineers and Firemen's Arbitration of 1915.

DESCRIPTIVE GEOMETRY. By William L. Ames and Carl Wischmeyer. 5th ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 112 pp., 197 illus., 8 × 5 in., cloth, $1.

A condensed course for students in colleges of engineering, in which seventy-two problems are explained and illustrated, and four hundred exercises for solution are

presented. The book accords with drafting office practice by using the third quadrant.

THE FLOTATION PROCESS. By Herbert A. Megraw. 2d ed., revised and enlarged. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 11 + 359 pp., 74 illus., 1 pl., tab., 9 × 6 in., cloth, $3.50.

Although litigation over patent rights still continues and there is still no agreement on the theory of the flotation process, the author has thought it advisable to issue a second edition of this work. In it the development of the process, both in theory and practice, is summarized, and an endeavor has been made to present as true a record of present conditons as is possible. Most of the original edition is retained, although some portions that later developments have made valueless are omitted, and considerable new matter has been added.

FUEL ECONOMY IN BOILER ROOMS. A Development of Fuel Economy and CO_2 Recorders. Published in the Engineers' Study Course from Power. In two parts. Part I. Fuel Economy and CO_2 Recorders. By A. R. Maujer and Charles H. Bromley. Part II. Fuel Economy in Boiler Rooms. By Charles H. Bromley. 2d ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Pub. Co., Ltd., 1918. 13 + 308 pp., 92 illus., 18 tab., 8 × 6 in., cloth, $2.50.

The volume before us contains a revised edition of the book formerly published as "Fuel Economy and CO_2 Recorders" with the addition of matter on other subjects of interest in connection with efficiency in power-plant operation. The authors have tried to provide a work that will explain in simple language the proper means of attaining fuel economy. For use by firemen and power plant operating engineers.

GEORGE WESTINGHOUSE. His Life and Achievements. By Francis E. Leupp. Boston, Little, Brown and Co., 1918. 10 + 304 pp., 5 pl., 6 por., 9 × 6 in., cloth, $3.

In this account of George Westinghouse, the inventor and the man, the author has gathered his material from such contemporary sources as old newspapers and magazines, corporate reports, court records, local traditions, and the personal recollections of the friends and neighbors of Mr. Westinghouse. The trials and failures of his early life, his perseverance in the struggle for the recognition of his air-brake, and his later successes, are pictured in detail. The numerous personal anecdotes which are scattered through the book add greatly to the interest of the biography as a human document.

INTERPOLATION TABLES OR MULTIPLICATION TABLES OF DECIMAL FRACTIONS. Giving the Products to the Nearest Unit of all Numbers from 1 to 100 by 0.01 to 0.99 and from 1 to 1000 by 0.001 to 0.999. By Henry B. Hedrick. Wash., Carnegie Institution, 1918. 139 pp., 14 × 10 in., cloth, $5.

These tables are of especial use in all problems involving the multiplication of decimal fractions of two or three digits where the product is required to no more significant figures than are contained in the smaller factor. Their use may be extended to decimal fractions of three and four digits. As the tables are more accurate than the slide-rule or graphical methods, and more convenient than logarithms, they are of value for many computations where those methods are ordinarily employed.

METALLURGY OF LEAD. By H. O. Hofman. 1st ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Pub. Co., Ltd., 1918. 664 pp., 705 illus., 1 folded pl., 153 tab., 9 × 6 in., cloth, $6.

This work replaces the author's former treatise on "The Metallurgy of Lead and the Desilverization of Base Bullion," but has been so largely rewritten and altered that it has become practically a new book. Only the chapters on reverberatory smelting and German cupellation have been retained in about their original forms. The author has prepared for the new edition by a careful review of the technical literature and by visiting the leading lead plants of the United States and Canada, and has attempted to represent modern practice thoroughly and accurately.

METHODS OF MEASURING TEMPERATURE. By Ezer Griffiths. With an Introduction by E. H. Griffiths. Lond., Charles Griffin and Co., Ltd.; Phila., J. B. Lippincott Co., 1918. 176 pp., 81 illus., 48 tab., 9 × 6 in., cloth, 8s 6d. (Gift from J. B. Lippincott Co.)

This monograph, intended for those concerned with the measurement of temperature in scientific investigations or in the control of industrial operations, is chiefly devoted to the experimental basis of the methods in use, the calibration of the instruments, and the precautions necessary in practice. The volume is intended to extend the general treatment given in standard textbooks and to be complete in itself. References to the important literature are given with each chapter.

MINE TRACKS. Their Location and Construction. Treating Briefly on the Materials Used and the Principles Involved in the Design and Installation, with a

Set of Rules for a Standard Practice. By J. McCrystle. 1st ed. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1918. 10 + 105 pp., 23 illus., tab., 7 × 5 in., flexible cloth, $1.50.

The adaption of mechanical haulage and the successive increases in the weight of mine locomotives and rolling stock are making closer attention to mine tracks imperative. This treatise furnishes a summary of the methods by several companies where systematic attention has been given to the subject, in convenient form for use by those responsible for the planning and maintenance of trackwork.

PLANE SURVEYING. A Practical Treatise on the Art of Plane Surveying, Including Chaining, Leveling, Compass, and Transit Measurements, Land and Construction Surveying, Topographic Surveying, and Mapping. By J. K. Finch. Chic., American Technical Society, 1918. 243 pp., 154 illus., 11 pl., 10 tab., 7 × 5 in., flexible cloth, $1.50.

This manual is especially intended for home study. It is planned to give the practical man a working knowledge of the subject, and to be used by trained surveyors as a convenient review.

THE SECOND POWER KINK BOOK. A Collection of Short Articles from *Power* in which Practical Men Describe Simple Expedients They Have Found Effective in Meeting Every-day Emergencies in Power-plant Work. Compiled by the Editorial Staff of *Power* (McGraw-Hill Book Co., Inc., sole selling agents), 1918. 11 + 161 pp., 137 illus., 9 × 6 in., ½ cloth, $1.

The first "Power Kink Book," published in 1917, has led to requests for further notes on emergency power-plant practice. This book, like its predecessor, is intended to suggest solutions for unusual problems and methods of meeting difficult situations.

SHEET-METAL WORKERS' MANUAL. A Complete, Practical Instruction Book on the Sheet-metal Industry, Machinery, and Tools, and Related Subjects, Including the Oxyacetylene Welding and Cutting Process. By L. Broemel. With a Special Course in Elementary and Advanced Sheet-metal Work and Pattern Drafting for Technical and Trade School Instructors and Students; Also for Reference and Study by Sheet-metal Workers and Apprentices. By J. S. Daugherty. Chic., Frederick J. Drake & Co. (copyright, 1918). 552 pp., 394 illus. 32 tab., 7 × 5 in., flexible cloth, $2. (Gift from the Peck, Stow, & Wilcox Co.)

The authors have tried to produce a comprehensive textbook on the machinery, tools, and methods used in sheet-metal working, suited to the needs of manual-training and trade schools. Outline courses in sheet-metal work and hand forging and welding which meet the requirements of emergency war training are included.

THE ZINC INDUSTRY. By Ernest A. Smith. Lond. and N. Y., Longmans, Green & Co., 1918. 223 pp., illus., 2 diag., 4 pl., 1 map, tab., 9 × 6 in., cloth, $3.50.

The author of this volume of the series of Monographs on Industrial Chemistry has written a general survey of the development of the zinc industry and its present and possible future position in relation to the various metal industries of Great Britain. The rise and progress of the industry, the new materials and their sources, marketing of ores and metal, smelting, physical and chemical properties, industrial applications, and alloys are considered and a bibliography of the more important publications is appended.

BIOGRAPHICAL NOTICES

CHARLES G. ROEBLING

Charles Gustavus Roebling, president of the John A. Roebling's Sons' Co., of Trenton and Roebling, N. J., and of the New Jersey Wire Cloth Co., of Trenton, and vice-president of the John A. Roebling's Sons' Co., of New York, died at his home, No. 333 West State Street, Trenton, on Oct. 5, 1918.

Mr. Roebling, who was born in Trenton, was a son of the John A. Roebling who finished the plans for the Brooklyn Bridge just before he died. The bridge was completed by his sons, Charles G. Roebling and Col. Washington A. Roebling.

Upon graduation from the Rensselaer Polytechnic Institute in 1871, Charles Roebling became associated with the Roebling company as a mechanical engineer. He was engineer and builder of the suspension

bridge at Oil City, Pa.; engineer and contractor of machinery for the removal of the Cleopatra Needle from Alexandria, Egypt, to Central Park in 1881; and contractor and builder of cables for the Williamsburg suspension bridge, the second of the great spans to be constructed across the East River. The plants under his management at Trenton and Roebling included seven large wire mills, the largest rod mill in the country, a wire cloth factory, one of the largest rubber mills and copper wire insulating plants in the country, and two large wire rope factories, twice destroyed by fire and rebuilt.

In addition to his other activities Mr. Roebling was a member of the New Jersey State Legislature in 1903, was Presidential Elector for New Jersey in 1911, and served as Commissioner of Water Works at Trenton and at Atlantic City. He was a member of the Iron and Steel Institute of Great Britain and of America, the American Institute of Mining Engineers, the Engineers' Club of New York, the Lotus Club of Trenton, and a director of the Mercer Automobile Company.

He is survived by two daughters, Mrs. Richard McCall Cadwalader and Mrs. Carrol Sergeant Tyson, both of Philadelphia, and a sister, Mrs. Charles Jarvas, of New York and Chicago.

JOSEPH HARTSHORNE

Joseph Hartshorne was born in Philadelphia in 1852. He died Aug. 23, 1918. After graduating from Haverford College, he took a special course in chemistry at the Massachusetts Institute of Technology, and later at the University of Pennsylvania. He started with The Pennsylvania Steel Co. as an apprentice in 1873, working in the laboratory and mills for 2 years, and then 1 year as foreman in the Bessemer Department. Next, he was assistant chemist in the second Geological Survey of Pennsylvania. In 1878, he went to France to investigate the Pernot open-hearth furnace for the Cambria Iron Co. Upon his return, he assisted in designing and erecting the plant in Johnstown and was foreman of a turn for 1 year, and superintendent for the next. In 1881, he became superintendent of the Bessemer and rolling-mill departments. In 1884, he went to Pottstown and also made a trip to Europe to investigate the Bessemer basic process. Upon his return he designed and erected the basic Bessemer plant for the Pottstown Iron Co., and was superintendent there until 1893, when the company failed. Since then he has been a consulting metallurgical engineer, and expert in patent cases. The most important of the latter was that of Krupp versus Midvale on the armor-plate patent case, in which he was leading expert for Midvale. He was a good linguist, having good command of French and German, and a fair knowledge of Italian and Spanish. In all, he made eight professional trips to Europe.

JOHN HAMILTON TROUTMAN

John Hamilton Troutman was born March 3, 1856, at Philadelphia, Pa. When he was fifteen his father died and it became necessary for the son to help to support his mother and sister. He accordingly went to work in a country store in the anthracite region, but continued his studies, and four years later received a teacher's certificate. About this time, he became associated with John Price Wetherill and August and Richard Heckscher in the management of coal properties. When the Lehigh Zinc Co. was organized, in 1881, he joined it and occupied several

positions of responsibility in the organization until the company was taken over by The New Jersey Zinc Co. in 1897.

Those who remember the very uncomfortable first year of the consolidation will always retain grateful memories of Mr. Troutman's kindliness, helpfulness, and absolute fairness. He only remained in the New York office for about a year and then went to Chicago, as the general manager of the Mineral Point Zinc Co. While there, he made many new friends and, among other things, started the manufacture of lead oxide from the mixed sulfides of the West. In June, 1900, he left Chicago for Denver to take charge of the Empire Zinc Co. This position proved to be the greatest opportunity of his life. No one who has not traveled in the West can begin to appreciate the high esteem in which he was held there by everyone with whom he came in contact—business associates, miners, mine operators, and competitors. He was always and everywhere absolutely fair and there was hardly a mine operator in the West who did not prefer to do business with Mr. Troutman. The reputation which his unfailing courtesy and fairness gained for the company is one of its greatest assets.

Of late, he felt the severe strain of his many years of hard and continuous work for the company and had been forced to take a less active part. He died quite suddenly at Denver on October 2. In his death, the company has lost one of its oldest, most faithful, and most valuable employes. As one of his oldest associates says, "J. H. Troutman, single-minded always in his devotion to his employers and his associates, was a man of unusual gifts and of dynamic working ability. It was a common saying of ours that his pencil was always sharpened for the most thorough-going investigation of any proposition brought to his attention, and that he never failed to state his well grounded conclusions." But more than his energy, ability, and conscientious performance of every duty was the fine character of the man, his kindliness, absolute fairness to, and consideration for every one with whom he came in contact.

G. C. STONE.

DR. ANDREW DICKSON WHITE

All branches of the engineering profession mourn the death of Dr. Andrew Dickson White, which occurred Friday, Nov. 1. Born Nov. 11, 1832, in Homer, N. Y., Mr. White began his diplomatic career soon after graduating from Yale University in 1859, when he became a member of the American Legation in St. Petersburg. Later he served as Minister to Germany under President Hayes, Minister to Russia under President Harrison, and Ambassador to Germany under President McKinley. He also was a member of the Santo Domingo Commission, the Venezuelan Commission, Commissioner of the Paris Exposition, and a member of the International Peace Conference at The Hague in 1899. But it is as an educator that he is best known. When New York state secured about 1,000,000 acres of public land as an endowment of its higher educational institutions, Ezra Cornell offered the state $500,000 for the endowment of the institution if the state would found a new school in Ithaca and transfer to it this public land. The state accepted the gift and Mr. White was invited to become one of the founders and the first president of Cornell University. He personally contributed $300,000, and later founded the school of history and political science, bearing his name, giving to it his historical library of over 40,000 volumes.

MEMBERSHIP

NEW MEMBERS

The following list comprises the names of those persons who became members during the period Oct. 10, 1918, to Nov. 9, 1918.

ALLER, FRANK D., Copper Met., Ore Purchaser, American Smelt. & Refin. Co., 120 Broadway, New York, N. Y.
AVERY, PAUL W., Met. Engr., Esperanza Min. Co., Apt. 8, El Oro, Mex., Mexico.
BAKER, CHARLES A., Leaching Foreman, Copper Leaching Plant, Anaconda Copper Min. Co., Anaconda, Mont.
BREED, CHARLES H..................Met., Crown Cork & Seal Co., Baltimore, Md.
CHASE, R. L., Min. Engr.......1028 First National Bank Bldg., Denver, Colo.
EICHELBERGER, FRANK, Vice-pres. and Engr., New York-Montana Testing & Engrg. Co., Helena, Mont.
GESTER, G. C., Geol., Standard Oil Co. of Cal., 616 Standard Oil Bldg., San Francisco, Cal.
GRIFFIN, JOHN, Mgr., Anthracite Territory, The Dorr Co., Board of Trade Bldg., Scranton, Pa.
HAYNES, ELWOOD..........Pres., The Haynes Stellite Co., Kokomo, Indiana.
HSI, T. C......................Sec'y, Tayeh Iron & Steel Works, Tayeh, China.
HYDE, AUSTIN T., Mgr., Keokuk Plant, River Smelt. & Refin. Co., 607 Franklin St., Keokuk, Iowa.
IKEDA, KENZO, Supt. & Chief Met., Fujita & Co., Kosaka Mines, Akitaken, Japan.
JOB, ROBERT, Vice-pres., Milton Hersey Co., Ltd., 84 St. Antoine St., Montreal, P. Q., Canada.
KERN, EDWARD F........Prof. of Met., School of Mines, Columbia Univ., New York.
KLINCK, FRED E.......Mech. Engr. & Met., H. Mueller Mfg. Co., Decatur, Ill.
KOCH, ERNEST C..................Min. Engr., Burma Corpn., Burma, Asia.
LANGDON, PALMER H.......Editor, *The Metal Industry*, 99 John St., New York, N. Y.
LAWLER, EDWARD W., Mgr., Hardinge Conical Mill Co., 120 Broadway, New York, N. Y.
LEWIS, ESSINGTON, Chief Asst. to Gen'l Mgr., Broken Hill Proprietary Co., Ltd., 320 Collins St., Melbourne, Australia.
LUCAS, GEORGE W.............Topographer, Roxana Petroleum Co., Tulsa, Okla.
MACFARLAND, A. FREDERIC, Met., U. S. Ball Bearing Mfg. Co., Palmer St. & Kolmar Ave., Chicago, Ill.
MARSH, A. L.......Gen'l Mgr., Hoskins Mfg. Co., 144 Atkinson Ave., Detroit, Mich.
MATTHIAS, MAXIMILIAN PAUL, Lieut., Ordnance Dept., U. S. A., 194 Nesmith St., Lowell, Mass.
MEISEL, H. J........................Geol., Elm Orlu Min. Co., Butte, Mont.
MELLOTT, E. L.....Chem., duPont Nitrate Co., Oficina Pena Grande, Iquique, Chile.
MYERS, JOHN F...........Met., The Empire Zinc Co. of Colo., Canon City, Colo.
NORTON, A. B., Gen'l Mgr., Riverside Metal Refin. Co., Box 633, Connellsville, Pa.
NUTTING, WALLACE HUNT, Master of Transportation, Washoe Reduction Wks., Anaconda Copper Min. Co., Anaconda, Mont.
OSBORN, L. A., Min. & Constr. Engr., L. A. Osborn Engineering Co., Welch, W. Va.
PLENKHARP, IRVIN H., Vice-pres. & Treas., The Atlas Brass Foundry Co., Columbus, Ohio.
ROBERTS, R. T...............Gen'l Supt., Waclark Wire Co., Elizabeth, N. J.
ROBINSON, LOUIS G., Engr. & Chem., Cincinnati Testing Bureau, 31 E. 4th St., Cincinnati, Ohio.
RUFFNER, JULIUS M....Pres. & Mgr., Atlin Gold Mines Co., Atlin, B. C., Canada.
SEIFERT, CHARLES G., Sec'y-Treas., Cons. Rolling Mills & Fdries. Co., S. A., Apartado 81, Mexico City, Mexico.
SHUTTS, SAMUEL B..................Supt., Lavino Furnace Co., Lynchburg, Va.
SNYDER, CHARLES G., Chief Chem., Duquesne Reduction Co., Grass & Yew Sts., Pittsburgh, Pa.
STOKESBURY, CHARLES H.........Met., Chase Rolling Mill Co., Waterbury, Conn.
STORM, L. W., Mine Supt., Latouche Mine, Kennecott Copper Corpn., Latouche, Alaska.
THOMPSON, B. S., Vice-pres., Hoyt Metal Co., 1506 Boatmens Bank Bldg., St. Louis, Mo.

THUM, ERNEST E., Western Editor, *Chemical & Metallurgical Engineering*,
Newhouse Bldg., Salt Lake City, Utah.
TROTT, M. J., Asst. Supt., Golden Cycle Min. & Reduc. Co., Colorado Springs, Colo.
VAN LIER, R. J., Gen'l Mgr., Billiton Maatschappy, Tandjong-Pandan,
Billiton, Netherlands East India.
WALZ, ANDREW..Asst. to Pope Yeatman, War Industries Board, Washington, D. C.
WERTHEIMER, JOSEPH, Met., D. E. O. C., N. A., Watervliet Arsenal, Watervliet, N. Y.
WICHMAN, FRANK M., Min. Engr., Mgr., Bauchelle & Wichman,
612 Walker Bank Bldg., Salt Lake City, Utah.
WILLIAMS, LOUIS W., Mgr., The Union Drawn Steel Co.,
460 Washington St., New York, N. Y.
YAMAMOTO, NOBUO, Chief Engr., Sumitomo Coal Dept.,
Sumitomo-Tadakuma Colliery, Fukuoka, Japan.
YARDLEY, J. L. McK., Capt., Engineers, U. S. A.,
Co. 4, E. O. T. S., Camp Humphrey, Va.

Associates

ALEXANDER, EDWARD, Asst. to Chief Accountant, American Smelt. & Refin. Co.,
Apartado 101, Monterrey, N. L., Mexico.
BRADY, D. M.....Pres., Brady Brass Co., 170–182 Fourteenth St., Jersey City, N. J.
BUTTFIELD, W. J............Pres., The Vulcan Detinning Co., Sewaren, N. J.
CARNS, WILLIAM F., Adv. Rep., Brass World Publishing Co.,
Elm & Duane Sts., New York, N. Y.
FRASER, JAMES........Supt., Speakman Co., Riverview Wks., Wilmington, Del.
GERO, W. B., Chem. Engr., Westinghouse Lamp Co., 165 Broadway, New York, N. Y.
GOEHRINGER, CHARLES J., Pres., The Buckeye Products Co.,
919–29 W. 5th St., Cincinnati, Ohio.
HANNAY, GERALD, Oscar Barnett Foundry Co., Lyons Ave. & Coit St., Irvington, N. J.
HARDY, WILLIAM C........Sec'y, Wm. A. Hardy & Sons Co., Fitchburg, Mass.
HOLMES, A. G.......Pres. & Mgr., Pittsburgh Meter Co., East Pittsburgh, Pa.
JENNINGS, EDWARD B...........Cadet, 41st Class, School of Fire, Ft. Sill, Okla.
LASNER, DAVID..............Met. Chem., Chemical Warfare Section, U. S. A.
LONG, GEORGE E.......Vice-pres., Joseph Dixon Crucible Co., Jersey City, N. J.
MUELLER, PHILIP....................Supt., H. Mueller Mfg. Co., Decatur, Ill.
ROSS, HENRY A..........................Ross-Tacony Crucible Co., Tacony, Pa.
WHITCOMB, HERBERT HARTWELL..Met. Engr., Scovill Mfg. Co., Waterbury, Conn.
YAUCH, OTTO LEOPOLD, Chief Engr., Bennett Mine, Bennett Min. Co.,
Keewatin, Minn.

Junior Associates

BORCHERDT, EDWARD RAHR, Student, Michigan College of Mines, Houghton, Mich.
BURBANK, WILBUR S., Student, Mass. Institute of Technology, Cambridge, Mass.
KIESEL, ALBERT H., Assayer, Ouray Consolidated Min. & Reduction Co., Ouray, Colo.
PEHRSON, ELMER WALTER..........Co. 6, E. O. T. S., Camp A. A. Humphreys, Va.
REIS, JAMES W., JR., Student, Mass. Institute of Technology, Cambridge, Mass.

Change of Status, Junior Associate to Member

CARUTHERS, ANTHONY WAYNE, Colliery Supt., Bliss Colliery, D. L. & W. R. R. Co.,
Nanticoke, Pa.

Change of Status, Junior Associate to Associate

SMITH, BERT F., Field Engr., American Smelt. & Refin. Co.,
1406 Old National Bank Bldg., Spokane, Wash.

Total Membership, Nov. 9, 1918............................7201

CHANGE OF ADDRESS OF MEMBERS

The following changes of address of members have been received at the Secretary's office during the period Oct. 10, 1918 to Nov. 9, 1918.

This list together with the list published in Bulletins No. 133 to 143,

January to November, 1918, and the foregoing list of new members, therefore, supplements the annual list of members corrected to Jan. 1, 1918 and brings it up to the date of Nov. 9, 1918.

ADAMS, ARTHUR K....Lieut., 2d Engr. Training Regt., Camp Humphreys, Va.
ADAMS, WALTER C................545 Dorchester St. W., Montreal, Canada.
ALEXANDER, WILLIAM H., Gen'l Mgr., Walker River Copper Co., Produce Exchange Bldg., New York, N. Y.
ALLPORT, R. H., The Aluminum Castings Co., 2800 Harvard Ave., Cleveland, Ohio.
ANDERSON, AMIL A., Co. A, 309th Regiment Engineers, 84th Div., American E. F., Care Postmaster, N. Y.
ARCHBALD, JOHN C..........................Apartado 55, Guanajuato, Mexico.
ARMSTEAD, H. H..................................Major, Engr. Corps, U. S. A.
ARMSTRONG, HAROLD KERR, Pilot, Naval Aviation, U. S. Naval Air Station, Miami, Fla.
BACKUS, GEORGE S..................1st National Bank Bldg., Telluride, Colo.
BARNES, W. A.........................576 Mills Bldg., San Francisco, Cal.
BARRETT, LESLIE P..........Lieut., Headquarters, 5th F. A., American E. F.
BASSETT, ARTHUR F................Co. 6, E. O. T. C., Camp Humphreys, Va.
BASSETT, THOMAS E., Corp., Bat. B, 147th Field Artillery, American E. F., Care Postmaster, N. Y.
BEDDALL, THOMAS H., Adjutant, 1st Bat., 1st Gas Regiment, American E. F., Care Postmaster, N. Y.
BENSON, PAUL T................Great Metals Min. & Mill. Co., Nespelem, Wash.
BERNARD, CLINTON P., Candidate, 12th Observation Battery, F. A. C. O. T. S., Camp Taylor, Ky.
BINGHAM, RAYMOND A................101 Sherman Ave., Glen Ridge, N. J.
BLACK, FREDERICK C..Belmont, Nev.
BOISE, PAUL T., 2d Regiment, 24th Squadron, S. P. D., U. S. A., Vancouver Barracks, Wash.
BORNHOFT, HENRY......................Apartado 70, Mexico City, Mexico.
BOWMAN, F. C.........................1903 West Ninth St., Spokane, Wash.
BROCKMANN, GUILLERMO..........110 Calle Liverpool, Mexico City, Mexico.
BROWNING, EDWARD, Corp., Co. D, 1st Regiment Engineers, American E. F., Care Postmaster, N. Y.
BUGBEE, EDWARD E..................S. A. T. C. Headquarters, Raleigh, N. C.
BURT, CURTIS F., Co. B, 1st Engineers Replacement Regiment, Washington Barracks, D. C.
BURTON, GEORGE E., Resident Geol., Empire Gas & Fuel Co., 1216 Colcord Bldg., Oklahoma City, Okla.
BUTTERFIELD, G. BRUCE, Co. C, 605th Engineers, American E. F., Care Postmaster, N. Y.
CADOT, J. J., 1st Lieut., U. S. Air Service, American E. F., Care Postmaster, N. Y.
CAMPBELL, A. R., Asst. to Sec., Lead Producers Committee for War Service, 61 Broadway, New York, N. Y.
CAMPBELL, W. C......................Care Ivanpoh Mining Co., Cima, Cal.
CARLOCK, J. B., Major, 2d Bat., 1st Gas Regiment, American E. F., Care Postmaster, N. Y.
CARPENTER, EDWIN E...Tonopah, Nev.
CHASE, E. E....................1028 First National Bank Bldg., Denver, Colo.
CHEYNEY, J. S..................735 Myrtle Ave., South Side, Charleston, W. Va.
CLEMMITT, WILLIS B..................................209 State St., Harrisburg, Pa.
CLARK, GEORGE B...................Capt., Engineers, Camp Funston, Kansas.
COBB, H. M..............Gen'l Mgr., Soto Mines Co., Guanacevi, Dgo., Mexico.
COLEMAN, W. H., Corp., Co. E, 23d Engineers, American E. F., Care Postmaster, N. Y.
CORBY, HARRY G., 1st Lieut., Co. D, 109th Supply Train, American E. F., Care Postmaster, N. Y.
CORSE, W. M.....................Engr., The Ohio Brass Co., Mansfield, Ohio.
CRAFTS, WALTER N., Asst. Gen'l Supt., British Forgings, Ltd., Toronto, Ont., Canada.
CRERAR, GEORGE...............Dayton Placer Recovery Corpn., Dayton, Nev.
CRISPELL, C. W., Specification Dept., Production Engrg., Bureau of Aircraft Production, 25 N. Main St., Dayton, Ohio.
DAGGETT, ELLSWORTH................10 Cummings Apt., Salt Lake City, Utah.
DAVELER, ERLE V......Mill Supt., Butte & Superior Min. Co., Butte, Mont.

DAVIS, THOMAS........................540 30th Ave., South, Seattle, Wash.
DAVY, WILLIAM M., Ensign, U. S. N. R. F., Naval Aviation Detachment,
Mass. Institute of Technology, Cambridge, Mass.
DECAMP, W. V...........Lieut., 428th Engineers, Camp Cody, New Mexico.
DERBY, C. C.............................Box 459, Route B, San Jose, Cal.
DESHAYES, ERNEST V.......................................Dragon, Utah.
DESHLER, GEORGE O........................Columbia Gardens, Butte, Mont.
DICK-CLELAND, A. F.................Major, 170th Co., R. E., British E. F.
DIETZ, J. H...........................1223 Bender Ave., Cleveland, Ohio.
DUB, GEORGE D...................................Franklin, Sussex Co., N. J.
DYE, ROBERT E., Care Teck-Hughes Gold Mines, Ltd., Kirkland Lake, Ont., Canada.
ELDRED, B. E............................18 East 41st St., New York, N. Y.
ELLIS, HENRY R.......Min. & Met. Engr., 39 G Street, Salt Lake City, Utah.
EMMEL, RUDOLPH...........................6 Glenside Ave., Jamaica Plains, Mass.
EMMONS, N. H., 2D, Head of Operation Division, Air Nitrates Corpn.,
Muscle Shoals, Ala.
ENEBO, BENJAMIN A...........................P. O. Box 772, McGill, Nev.
ERDOFY, MAXWELL E., 2d Lieut., Co. C, 602d Engineers, American E. F.,
Care Postmaster, N. Y.
FLYNN, FRANCIS N., Asst. Gen'l Supt., Balbach Smelt. & Refin. Co., Newark, N. J.
FORBES, JOHN J. V., Min. Engr., U. S. Bureau of Mines,
4800 Forbes St., Pittsburgh, Pa.
GABY, WALTER E...................208 Douglas Ave., Salt Lake City, Utah.
GARRIDO, MANUEL F., Negociacion Minera de Santa Maria de la Paz,
Avenida Uruguay 70, Mexico, D. F.
GARRISON, MURRAY E......5th Cadet Squadron, Ellington Field, Houston, Tex.
GAZZAM, JOSEPH P......................5295 Waterman Ave., St. Louis, Mo.
GLINES, CHARLES H., JR.......60 N. 7th Ave., Highland Park, New Brunswick, N. J.
GODSHALK, E. G........................Bartlesville Zinc Co., Blackwell, Okla.
GOODALE, STEPHEN L., Capt., Ord. U. S. A., Bureau of Mines Bldg.,
4800 Forbes St., Pittsburgh, Pa.
GREENWOOD, C. L., Lieut., Aero Squadron, Barracks 52, Ellington Field,
Houston, Tex.
GRIFFITH, WILLIAM V.............................Min. Engr., Christmas, Ariz.
GWINN, JAMES W...........................206 Market Ave. E, Kellogg, Idaho.
HALL, C. J...................Copper Queen Reduction Works, Douglas, Ariz.
HAMMILL, CHESTER A.........................Box 12, Mineral Wells, Tex.
HARDIE, A. B...................Chief Engr., Lavino Furnace Co., Lebanon, Pa.
HARRIS, W. G...................Supt., Bush Mine, Stewart, B. C., Canada.
HARTLEY, BURTON, Capt., 45th Artillery, C. A. C., 37th Brigade, C. A. C.,
American E. F., Care Postmaster, N. Y.
HASTINGS, JOHN B...............................133 Ida Ave., Donora, Pa.
HAURY, P. S...................................3032 Colby St., Berkeley, Cal.
HAYES, FRANCIS H., Major, Army General Staff College, A. P. O. 714,
American E. F., France.
HERMSDORF, RICHARD P. E., Tank House No. 2, Raritan Copper Wks.,
Perth Amboy, N. J.
HERR, HERBERT T., Vice-Pres., Westinghouse Electric & Mfg. Co.,
Essington Wks., Lester, Pa.
HERZIG, C. S., Care George B. Herzig, 41 West 29th St., New York, N. Y.
HICKMAN, E. C...........Asst. Supt., St. Joseph Lead Co., Herculaneum, Mo.
HIGLEY, R. C.......................................88 Churchill, Detroit, Mich.
HILBERT, JEROME A..........................1237 8th St., Santa Monica, Cal.
HILL, WILLIAM J., 2d Lieut., 11th Training Battery, F. A. C. O. T. S.,
Camp Zachary Taylor, Ky.
HIPPARD, CLEMENCE W., 211 Transportation Bldg., University of Illinois, Urbana, Ill.
HOFFMANN, JOHN S.................1st Lieut., A. S. S. C., Gerstner Field, La.
HOLLAND, A. A.......................................Box 205, Tucson, Ariz.
HOLZHAUER, WILLIAM..........................30 Walnut St., Milton, Pa.
HOOK, J. S., Lieut., Headquarters First Unit, Wilbur Wright Field, Dayton, Ohio.
HOOKER, BRIAN, Commonwealth Bureau of Census & Statistics, Rialto,
Collins St., Melbourne, Australia.
HOULE, ALBERT J..............................Instructed to hold everything.
HOWARD, LOUIS ORRIN, Pres., School of Mines, State College of Washington,
Pullman, Wash.
HOWE, ALBION S. ....Care Central Eureka Mine, Sutter Creek, Amador Co., Cal.

HOWELL, JESSE V., 16th Training Battery, F. A. C. O. T. S., Camp Taylor, Ky.
HOYT, J. C. .... Jerome Junction, Ariz.
HSUEH, KWEI LUN .... Old Company's Club, Lansford, Pa.
INGERSOLL, GUY E .... U. S. Army.
INGLE, HUGH C ...... 472d Engineers, 7th & B Sts., S. W., Washington, D. C.
JENKINS, OLAF P., Geol., State Bureau of Mines, Univ. of Arizona, Tucson, Ariz.
JOHNS, ALFRED L .... 434th Engineers, Camp Kearny, Cal.
JOHNSON, F. A .... 135 Breading Ave., Ben Avon, Pa.
JONES, S. S., Min. Eng .... Box 496, Kingman, Ariz.
JONES, THOMAS J .... Pinners Hall, Austin Friars, London, E. C., England.
KELLEY, ARTHUR L .... Ray, Ariz.
KENNEDY, FRANK A., Cons. Engr .... 1006 Alworth Bldg., Duluth, Minn.
KEYES, HARMON EDWARD .... Artillery, U. S. A., Fort Worden, Wash.
KING, ROWLAND, 1st Lieut., Engineers, Camp Headquarters, Camp A. A. Humphreys, Va.
KITSON, H. W .... Ensign (T), U. S. N., U. S. S. Delaware, Care Postmaster, N. Y.
KOCH, H. E., Enlisted Ordnance Corps, U. S. A., Watertown Arsenal, Watertown, Mass.
KOHL, E. WILLIAM, JR .... 5914a Carpenter St., West Philadelphia, Pa.
LACHMUND, OSCAR .... Room 822, Paulsen Bldg., Spokane, Wash.
LAIN, J. B .... Mill Supt., Kennecott Copper Co., Latouche, Alaska.
LATHROP, LLOYD J., 1st Lieut., 529th Engineers, American E. F., Care Postmaster, N. Y.
LAUGHLIN, S. W .... 443 E. 1st So. St., Salt Lake City, Utah.
LAWRENCE, WILLIS, Mgr., Oat Hill Quicksilver Mines, Middletown, Lake County, Cal.
LEWIS, CLINTON R.... Candidate, Co. D, Candidate's School, Fort Monroe, Va.
LEY, HENRY A .... 417 East Locust St., Independence, Kansas.
LIHME, C. B .... 1200 Lake Shore Drive, Chicago, Ill.
LINDHOLM, MILTON S., Lieut., Co. C, 109th Engineers, American E. F., Care Postmaster, N. Y.
LINN, WILLIAM J .... Lieut., P. O. Station L, Congress Hts., D. C.
LIVERMORE, ROBERT .... 2d Co., E. O. T. S., Camp Humphreys, Va.
LOO, PANG C .... Yung Sheng Co., 39 Szechuen Road, Shanghai, China.
LYON, D. A .... U. S. Bureau of Mines, Pittsburgh, Pa.
MCCARTY, EDWARD P .... Co. 2, E. O. T. S., Camp A. A. Humphreys, Va.
MCHARDY, ROY H., Candidate, Co. C3, Coast Artillery Training School, Fort Monroe, Va.
MACY, G. D., 33d Training Battery, F. A. C. O. T. S., Camp Zachary Taylor, Ky.
MAHONEY, J. N .... Co. D, 39th Machine Gun Battalion, Camp Lewis, Wash.
MALLAMS, ARTHUR C .... Southern Illinois Engineering Co., Herrin, Ill.
MARBLE, RALPH N., Lieut. Comdr., The Marlborough, 917 18th St., N. W., Washington, D. C.
MARSHALL, EMORY M., Lieut., Ordnance Dept., American E. F., Care Postmaster, N. Y.
MAY, ALBERT E .... 231 Rawson Road, Brookline, Mass.
MEAD, Richard .... Corp., Div. C, Section 23, A. P. O. 718, A. E. F., France.
MILLER, DONALD G., Major; 4th Engr. Training Regt., Camp Humphreys, Va.
MILLER, E. A .... Box 425, Harrisburg, Ill.
MOORE, REDICK R., American Smelt. & Refin. Co., Aguascalientes, Ags., Mexico.
MORGAN, DAVID .... Mgr., Verde Combination Copper Co., Jerome, Ariz.
MORRIS, J. T .... Gen'l Mgr., Pemberton Coal & Coke Co., Affinity, W. Va.
MORRIS, JOHN M .... Student, Missouri School of Mines, Rolla, Mo.
MORRISON, HAROLD A .... 5237 College Ave., Oakland, Cal.
MORTON, ROSCOE B .... So. University St. & Harvard Ave., Denver, Colo.
MUNROE, CHARLES E., Chairman, Committee on Explosive Investigations, National Research Council, 1023 16th St., Washington, D. C.
NEGRU, JACQUES S., Spr., 2504000, 9th Bat., Canadian R. R. Troops, Canadian E. F.
NEWBAKER, EDWARD J .... 1100 Commercial Trust Bldg., Philadelphia, Pa.
NICHOLSON, GEORGE E .... 820 Commerce Bldg., Kansas City, Mo.
NIGHMAN, C. EDWIN .... 1st Lieut., Sig. R. C. (Aircraft Production).
OBERG, ANTON C .... 528 Manhattan Bldg., Duluth, Minn.
OLINGER, R. W ...... 35th Co. Central Machine Gun O. T. S., Camp Hancock, Ga.
OLIVEROS, R. P .... U. S. Army.
ORROK, GEORGE A., Cons. Engr .... 17 Battery Pl., New York, N. Y.
ORTEGA, PABLO .... Calle 6 y 25, Vedado, Havana, Cuba.
OTTO, JOHN F .... 38th Co., 10th Bat., Camp Upton, N. Y.

PALMER, R. N., Black Lake Asbestos & Chrome Co., Black Lake, Quebec, Canada.
PALMER, W. R. .... 1101 N. Oregon Ave., El Paso, Texas.
PARSONS, ARTHUR B. .... Butte & Superior Min. Co., Butte, Mont.
PARSONS, GEORGE H., Chemical Warfare Service, Gas Defense Div., Astoria, L. I.
POMEROY, W. E., Min. Engr. .... 65 West 44th St., New York, N. Y.
POWELL, DONALD A., 2d Lieut., Coast Artillery Corps, U. S. A., 62 South, Ft. Monroe, Va.
PRICE, HAROLD C., Lieut., 62d Artillery, C. A. C., American E. F., Care Postmaster, N. Y.
PRICE, JOHN M., 2d Lieut., Air Service Military Aeronautics, Post Field, Fort Sill, Okla.
RAMLOW, WILLIAM G. .... Gilman, Colo.
RANKIN, JAMES J., Sgt., Curtis Bay Ordnance Dept., Headquarters Co., So. Baltimore, Md.
REA, JOHN E. .... Box 564, Batesville, Ark.
REDFEARN, ALBERT M. .... Asst. Supt., McCord Mfg. Co., Detroit, Mich.
RISER, O. F. .... Asst. Supt. of Mills, Chino Copper Co., Hurley, New Mexico.
ROBINSON, H. E. .... Lincoln-Idaho Oil Co., Kemmerer, Wyo.
ROBINSON, HARRY O., Magnesite Min. & Mfg. Co., Porlamar, Isla de Margarita, Venezuela, S. A.
ROCCA, ANDREW, JR. ... Pres. & Supt., Western Mercury Co., Inc., Cloverdale, Cal.
SCHELL, H. B., Mine Surveyor, Mt. Bischoff Extended Tin Min. Co., N. L. Waratah, Tasmania.
SCHUETTE, CURT N. .... 930 Broderick St., San Francisco, Cal.
SCHULTZ, C. I. .... R. F. D. No. 2–74, Puente, Cal.
SCOTTEN, FRANK .... Montana Power Co., Butte, Mont.
SEIBERT, PERCY A. .... 905 Potomac Ave., Hagerstown, Md.
SENG, CHAN KEY .... Care Stone & Webster, Columbus, Ga.
SHAW, JOSEPH H. .... 1503 Farmers Bank Bldg., Pittsburgh, Pa.
SHEAFE, HARRY J. .... U. S. Army.
SHEARER, HAROLD K., Field Artillery Officers' Training School, Camp Zachary Taylor, Ky.
SIRDEVAN, WILLIAM H., Efficiency Engr., United Verde Copper Co., Jerome, Ariz.
SKIRM, J. G. .... U. S. Army.
SMITH, CECIL W. .... Nokomis Coal Co., 1380 Old Colony Bldg., Chicago, Ill.
SMITH, FRANK A. .... 2d Batt., Det. C., C. W. S., Edgewood, Md.
SMITH, WILLIAM ALLEN .... 22 Paradise Road, Northampton, Mass.
SMYTH, JOHN G., Capt., Ordnance Dept., U. S. A., 3323 Claremont Ave., Berkeley, Cal.
STALNAKER, RANDOLPH .... Beverly, Randolph Co., W. Va.
STEIDLE, EDWARD, Capt., Co. D, 30th Engineers, American E. F., Care Postmaster, N. Y.
STEWART, JOHN S. .... Co. 1A, E. O. T. S., Camp Humphreys, Va.
STILLMAN, CHARLES A., Vice-pres., Iroquois Iron Co., 111 West Washington St., Chicago, Ill.
STOCKWELL, R. K., Gen'l Sales Mgr., Robins Conveying Belt Co., Park Row Bldg., New York, N. Y.
STONE, GEORGE C., Non-ferrous Metals Div., War Industries Board, Washington, D. C.
STROUT, ERNEST A., Mgr., La Fe Mining Co., Ltd., Guadalupe, Zacatecas, Mexico.
SULTZER, H. D. .... 1st Lieut., 47th Engineers, Fort Dodge, Iowa.
SWANSON, E. R. .... Capt., Ordnance Dept., Kensington, Md.
TALCOTT, M. GARDNER .... 40 Woodland St., Bristol, Conn.
TEAS, PIERSON .... 2d Lieut., U. S. A., Aberdeen Proving Grounds, Maryland.
TU, CHING FANG .... University of Utah, Salt Lake City, Utah.
TURNER, HENRY W. .... Mills Bldg., San Francisco, Cal.
UDY, MARVIN J. .... Chief Chem., Care Haynes Stellite Co., Kokomo, Ind.
VOLKER, H. J. .... Minas Tecolotes, Santa Barbara, Chic., Mexico.
WALTER, RAYMOND A. .... Capt., Co. B, 70th Engineers, Fort Douglas, Utah.
WARD, A. T. .... 5th Prov. Co., N. A., Camp Wadsworth, S. C.
WEBSTER, JOHN P. B., Mgr., Kyshtim Corpn., Ltd., Pinners Hall, Austin Friars, London, E. C., England.
WEIGEL, W. M. .. Supt., Smelt. Dept., Missouri Cobalt Co., Fredericktown, Mo.
WILLETS, ROBERT H., 1st Lieut., General Engineer Depot, Munitions Bldg., Room 2830, 19th & B Sts., N. W., Washington, D. C.
WILLIAMS, EDWARD I. .... Lieut., U. S. A., 65 South, Fort Monroe, Va.
WILLIAMS, FRED P., Min. Engr. .... 34 West 44th St., New York, N. Y.

WILLIAMS, P. T. ....Lieut., Royal Engineers, 6th Reserve Battalion.
WILSON, H. M., Director, Dept. of Inspection & Safety, The Associated Companies, 801 Chamber of Commerce Bldg., Pittsburgh, Pa.
WINANS, HENRY S. ....Chalmers & Williams, Inc., Chicago Heights, Ill.
WISE, ALFRED L., Ensign, U. S. N. R. F., Reserve Officers' Quarters A, Room 432, U. S. Naval Academy, Annapolis, Md.
WISHON, W. W., Cons. Engr., Big Casino Min. Co., Box 127, Searchlight, Nev.
WISSER, EDWARD HOLLISTER, 2d Lieut., 319th Engineers, American E. F., Care Postmaster, N. Y.
WOLF, ALBERT G. ....Field Engr., Mason Valley Mines Co., Thompson, Nev.
WOLFARD, O. L., Lieut. Com'dr, U. S. N., U. S. S. New Mexico, Care Postmaster, N. Y.
WOODWORTH, GUY THOMAS, 361st Ambulance Co., 316th Sanitary Train, American E. F., Care Postmaster, N. Y.
WRATHER, WILLIAM EMBRY ....6044 Bryan Parkway, Dallas, Texas.
WRIGHT, FREDERIC E. ....Major, Ordnance Dept., U. S. A.
WRIGHT, W. R., 1st Lieut., Ord. R. C., Inspection Div., Explosives Section, Loading Branch, N. Y. District.
YARDLEY, JOHN L. MCK., Co. B, 10th Engr. Training Regiment, Camp A. A. Humphreys, Va.

MEMBERS' ADDRESSES WANTED

Name. Last address of Record from which Mail has been returned.

ARMSTRONG, CLIFTON T. ....347 Manhattan Ave., New York, N. Y.
ASHMORE, E. P. ....504 Sherbourne St., Toronto, Ont., Canada.
BARNARD, C. W. ....North Chicago Hospital, 2551 N. Clark St., Chicago, Ill.
BARNETT, WILLIAM J. ....8 Waterloo Place, Pall Mall, London S. W., England.
BIRD, FRANK H. ....Butler Hotel, Seattle, Wash.
BLANCHARD, RALPH C. ....3 Lombard St., London, England.
BOAS, ROSS H. ....Highland Boy Mine, Bingham Canyon, Utah.
BREEDING, F. O. ....Eden Min. Co., Bluefields, Nicaragua.
BROOKE, LIONEL ....Minas del Tajo, Rosario, Sin., Mexico.
BROWNE, ARTHUR B. ....Malleable Iron Fittings Co., Branford, Conn.
BRYANT, GEORGE W. ....Apartado 86, Guanajuato, Gto., Mex.
BYERS, WHEATON B. ....50 Hampton Hall, Cambridge, Mass.
CONOVER, M. J. ....Hotel Bellevue, San Francisco, Cal.
DETERT, WILLIAM F. ....Jackson, Amador Co., Cal.
EHLERS, L. W. ....2137 St. Louis Ave., St. Louis, Mo.
DEFARIA, C. C., Fiscal das Estradas, Rua Condo do Bomfim, No. 46, Rio de Janeiro, Brazil.
FIELDING, SIR CHARLES ....Belmont, Faversham, Kent, England.
FRASER, EVERETT L. ....Oro Grande Mines, Callahan, Cal.
GOLDSMITH, OSHER ....Rolla, Mo.
HERR, J. CAMPBELL ....Box 556, State College, Pa.
HESS, K. F. ....Burro Mountain Copper Co., Tyrone, N. M.
HOVLAND, HENRY B. ....Los Angeles Athletic Club, Los Angeles, Cal.
HUNTER, CHARLES, Royal Colonial Institute, Northumberland Ave., London, W., England.
HURUM, FREDRIK J. O. ....Westmorley Court, Cambridge, Mass.
KAY, DAVID NELSON ....Ray Cons. Copper Co., Hayden, Ariz.
KING, FRANK E. ....Hotel Breslin, New York, N. Y.
KLEESATTEL, RICHARD ....911 White Bldg., Seattle, Wash.
KLUGESCHEID, WALTER P. ....616 W. 113th St., New York, N. Y.
KONSELMAN, ALBERT S. ....Globe, Ariz.
MEE, WHITNEY P. ....Apt. 14, Binkley Apts., El Paso, Texas.
MILLER, HARRY H. ....37 So. Stone St., Tucson, Ariz.
MORRIS, JOHN M. ....Rolla, Mo.
NICHOLSON, FRANCIS ....Charlotte Court House, Va.
RALEIGH, JOSEPH R. ....Rossville, via Cooktown, Queensland, Australia.
ROBERTS, EDWARD J., Gen'l Mgr., Nevada Pyramind Min. Co., Riverside Hotel, Reno, Nev.
ROSS, HERBERT W. ....314 Pacific Ave., Piedmont, Oakland, Cal.
SIMPSON, KENNETH M. ....57 Post St., San Francisco, Cal.
STICKNEY, WILLIAM H. ....708 N. Center St., Reno, Nev.
TAO, H. T. ....Rolla, Mo.

TAPLIN, THOMAS J., JR. . . . . 16 Lordship Park, London N. 16, England.
TONG, SING KOW . . . . 404 W. 115th St., New York, N. Y.
TREAT, LLOYD B., Canadian Ingersoll-Rand Co., Bank of Toronto Bldg., Montreal, Canada.
VANRENSSELAER, ARTHUR M . . . . 119 E. 51st St., New York, N. Y.
WILLIAMS, JOHN T . . . . 100 Broadway, New York, N. Y.
WONG, S. C. . . . . Care School of Mines, Butte, Mont.
WONG, YIN CHARLES . . . . Rolla, Mo.
WOO, W. K. . . . . M 70 Sing Kong Li, Minghong Road, Shanghai, China.
YEWELL, P. R., Leland Stanford, Jr., Univ., Box 1212, Stanford University, Cal.

NECROLOGY

(See also "Died in Service")

The deaths of the following members were reported to the Secretary's office during the month Oct. 10, 1918, to Nov. 10, 1918.

Date of Election.	Name.	Date of Death.
1917	Bowles, Martin F.	Sept. 3, 1918.
1913	Engelhardt, Eugene N.	——— 1918.
1915	Gordy, S. B.	Oct. 9, 1918.
1873	Hartshorne, Joseph	Aug. 23, 1918.
1914	Lee, Howard S.	Oct. 25, 1918.
1918	Nebel, Merle L.	Oct. 12, 1918.
1906	Roebling, Charles G.	Oct. 5, 1918.
1917	Smyth, Raymond W.	Sept. 27, 1918.
1914	Troutman, John Hamilton	Oct. 2, 1918.
1911	Verrill, Clarence S.	——— 1918.

CANDIDATES FOR MEMBERSHIP

APPLICATION FOR MEMBERSHIP.—The Institute desires to extend its privileges to every person to whom it can be of service. On the other hand, it is not desirable that persons should be admitted to membership in classes for which they are not qualified. Members of the Institute can be of great service if they will make a practice of glancing through the list of applicants and promptly notifying the Committee on Membership, or the Secretary of the Institute, of any persons whom they think should not be classified in accordance with the list given.

Applications Lacking Endorsement

Applications for membership have been received from Mr. Braecke and Mr. Wilkie, whose records are given below. These applications lack the necessary number of endorsers, but since these candidates live at some distance from the headquarters of the Institute, their records are published here in order that any members who are acquainted with them may be advised of the circumstances and may have an opportunity of writing to the Secretary endorsing these candidates.

Members

Gustave Braecke, La Carolina, Spain.

Proposed by A. DeDeken.

Born 1860, Nieuport, Belgium. 1886, Grad., School of Mines, Liége, Belgium, M. E. and Engr. of Arts and Manufacturers. 1887–91, Ore-dressing Dept., Humboldt Engng. Works, Kalk, Germany. 1891–1901, Prospecting, Northern Transvaal; Mgr., Molyneux mines, Witwatersrand, Transvaal. 1901–03, Mgr., Gwendoline gold mine, Korea. 1903–06, Mgr., Mina San Vicente, Société La Nouvelle Montagne, Spain. 1906–07, Prospecting for zinc, Djendli mine, Arzelia. 1907–11, Mgr., Ollin mines, North Spain. 1911–13, Reporting in Spain for Société d'Etudes Minière, Brussels. 1914–18, Mgr., Lead mines, Curas and Soldado, and Technical Mgr., New Cerdenillo, silver-lead mines, La Carolina, Spain.

Present position: Mgr., Société Curas et Soldado de Carolina.

Cyril Gordon Brink, Transvaal, So. Africa.
Born 1889, Grahamstown, So. Africa. 1900–05, High School. 1906–07, St. Andrews School. 1908–09, Chem., Rhodes Univ., Grahamstown. 1910–15, In Reduction Wks., Norse Gold Mines, Ltd., Johannesburg. 1915–17, Leading Shiftsman, and in chg. of reduction wks., Fairview gold mine, Transvaal Cons. Mines.
Present position—1917 to date: Reduction Officer, Fairview Devonian Montrose Gold Mines, Ltd.

Donald Cook Wilkie, Serembau, Federated Malay States.
Proposed by
Born 1879, Dundee, Scotland. Brothers' school, Penang, Straits Settlements; Baptists' School, Rangoon, Burmah; Donaldson's School, Dundee, Scotland; 1890–92, Wallacetown School, Dundee, Scotland. 1892–98, Mechanical and electrical construction and repair work; engr. experience; drafting room; shop at sea, Ross & Wilkie, Scotland. 1898–99, Asst. Engr., China Borneo Co., Ltd., Sandakan, B. N., Borneo. 1901–03, Salvage Dept., Tangong Pagar Dock Co., Ltd., Singapore. 1903–10, Engr., Pyritical Ore Installation, Sungei Besi recovery of tin stone from arsenical and sulphurous ores, The Straits Trading Co., Ltd., Sungei Besi, Malay States.
Present position—1910 to date: Supt. Engr., Linggi Plantations, Ltd.

The following persons have been proposed during the period Oct. 10, 1918, to Nov. 9, 1918, for election as members of the Institute. Their names are published for the information of Members and Associates, from whom the Committee on Membership earnestly invites confidential communications, favorable or unfavorable, concerning these candidates. A sufficient period (varying in the discretion of the Committee, according to the residence of the candidate) will be allowed for the reception of such communications, before any action upon these names by the Committee. After the lapse of this period, the Committee will recommend action by the Board of Directors, which has the power of final election.

Francis Spearman Adams, Anaconda, Mont.
Proposed by Frederick Laist, Louis V. Bender, Charles D. Demond.
Born 1881, Sharon, Pa. 1887–1897, Sharon Public Schools. 1900–01, Univ. Prep. School, Ithaca, N. Y. 1905, Cornell Univ., M. E. 1905–08, Steam Expert, C. F. & I. Co., Pueblo, Colo. 1908–10, Asst. Supt., Salem Iron Co., Leetonia, O. 1911, Supt., Constr., Charleroi Water Co. 1911–12, Owned and operated artificial ice plant. 1913–14, Engrg. Dept., C. F. & I. Co., Pueblo, Colo. 1914–15, Engrg. Dept., Anaconda Copper Min. Co. 1916, Asst. Supt., Power Dept., Anaconda Copper Min. Co. 1917, Supt., Power Dept., Anaconda Copper Min. Co.
Present position: Same as above.

George Edward Alderson, Camp A. A. Humphreys, Va.
Proposed by Charles H. Fulton, Frank R. Van Horn, C. B. Murray.
Born 1888, Cleveland, Ohio. 1894–01, Cleveland Public School. 1901–05, Cleveland Central High School. 1905–09, Grad., Case School of Applied Science, B. S. 1909–10, Chem., Chino Copper Co., Hurley, N. M. 1910–11, Assayer, Clear Creek min. at Mogollon, N. M. 1911–13, Chem., Ducktown Sulphur, Copper, Iron Co., Ltd., Isabella, Tenn. 1913–15, Night Smelter Supt., Plant Investigator, Nichols Copper Co., Douglas, Ariz. 1915–16, Chem., Min. Engr., Weedon Min. Co., Montreal, Canada. 1917–18, Chief Engr., South American Copper Syndicate, Ltd., London, E. C., England.
Present position: Student, Engineer Officers' Training School.

William Guy Broughton Boydell, Tul Mi Chung, Korea.
Proposed by A. R. Weigall, J. Mitchell-Roberts, D. W. Leeke.
Born 1881, Sidney, Australia. 1899–1904, Univ. of Sidney, B. S. . 1904, Trucking and min., No. 1 S. Oriental & Glanmire Gold Min., Gympie, Queensland. 1905, Min. and timbering. 1905–08, Assayer, Zinc Corpn., Broken Hill, N. S. W. 1908, Timbering, Broken Hill Junction, North mine, N. S. W. 1908–13, Assayer, Surveyor, and Asst. Mgr., Hercules Gold & Silver Min. Co., Tasmania. 1914–16, Shift Boss, Kapran copper mine, Korea. 1916–17, Underground Mgr., Kok Kang Kol mine, Korea.
Present position—1917 to date: In charge Ore Estimation and Survey Dept., Seoul Min. Co.

Gilbert Albion Bragg, Thompson, Nev.
Proposed by A. J. McNab, F. W. Guernsey, Walter H. Aldridge.
Born 1891, St. Joseph, Mo. 1912, Grad., Univ. of Kansas, B. S. 1911–12, Asst. and Chem., Kansas State Water Laboratory, Lawrence, Kans. 1912–14, Research Fellow, Mellon Institute Industrial Research, Univ. of Pittsburgh, hydrometallurgy of copper, laboratory research. 1914–16, Supt., and Chem., Experimental Plant, hydrometallurgy of copper, Thompson, Nev.
Present position—1916 to date: Senior Research Fellow, Mellon Institute Industrial Research, Univ. of Pittsburgh, charge all copper metallurgy investigations and mgr. experimental plant, hydrometallurgy of copper.

Hamilton Cooke, Jr., Butte, Mont.
Proposed by W. N. Rossberg, G. E. Sheridan, Israel O. Proctor.
Born 1887, Blue Rapids, Kans. 1912, Grad., Montana State School of Mines, E. M. 1912–13, Clerical and statistical work, Colusa Parrot Ore Testing Plant, Butte, Mont. 1914, Prospecting, Joplin District. 1914–15, Clerical and statistical work, Timber Butte Mill. Co., Butte, Mont. 1915–18, Agent, Cashier and Agency Organizer, New York Life Insurance Co.
Present position: Metallurgical Dept., Timber Butte Mill. Co.

Frank Belin Davenport, Kingston, Pa.
Proposed by Paul Sterling, Theodore L. Welles, Elmer H. Lawall.
Born 1879, Wilkes-Barre, Pa. 1909, Grad., Lafayette College, C. E. 1917, Post Grad., M. E. 1897–1900, Mine Engr. Corp., D. & H. 1900–02, Mine Engr., Aikman & Auman. 1902–05, Robt. Ireland, Mech. Engr., Wilkes-Barre, Pa. 1905–09, Lafayette College, Easton, Pa. 1906, Summer, North American Coal Co., Washery Co. 1907, Smith & Welles, Tunkhannock, Pa. 1908, North American Coal Co., Sugar Notch Washery. 1909–11, Asst. Mech. Engr., G. B. Markle Co.
Present position—1911 to present time: Cons. Engr., at Wilkes-Barre, Pa.

George Dunglinson, Jr., Bluefield, W. Va.
Proposed by Thomas H. Clagett, W. W. Coe, John Stewart.
Born 1882, Cockermouth, England. 1904, Alabama Polytechnic Institute, B. S. 1904–06, Min. Engr., Louisville Coal & Coke Co.; Greenbrier Coal & Coke Co.; Piedmont Colliery, Goodwill, W. Va. 1906–08, Min. Engr., charge of engineering work, mine development, construction work, installation of new collieries, Bramwell, W. Va. 1908–12, Member, Car Allotment Commission; 1912–17, Chairman, Car Allotment Commission, Norfolk & Western Railway, Bluefield, W. Va.
Present position: Asst. to General Manager, charge of fuel mines, Norfolk & Western Railway.

James L. Fozard, Latouche, Alaska.
Proposed by J. B. Lain, L. W. Storm, Henry M. Rives.
Born 1882, Sonora, Cal. 1900, Grad., Berkeley High School. 1900–03, Univ. of California. 1904, Power plant, Utica Co., Angels, Cal. 1906–09, Mine Foreman, Wild Goose Min. & Trading Co., Nome, Alaska. 1909–15, Prospecting and leasing, northern Nevada. 1915–16, Shift Boss and Field Engr., Alaska Gastineau Min. Co., and B. L. Thane Exploration Dept. 1917, Mine Foreman and Field Engr., Kennecott Copper Corpn.
Present position: Supt., Beatson Plant, Kennecott Copper Corpn.

Alexandre Gouvy, New York, N. Y.
Proposed by E. Gybbon Spilsbury, A. R. Ledoux, Jesse M. Smith.
Born 1856, Hombourg-haut, France. 1879, Grad., Ecole Centrale des Arts et Manufactures, Paris, Ing. des Arts et Manufactures. 1880–83, Volunteer and Engr., Blast Furnace and Steel Works, Resicza, Hungary. 1884–90, Tech. Secy. and Inspector, Vienna, Austria, French Co. 1891–93, Sub-director, Hutabankova (Ground Steel Works), Poland. 1893–95, Mgr., Stédes Forges d'Alais, Tamaris. 1896–1900, Mgr., Sté Komarova (Blast Furnace) Ufor (Ural).
Present position—1901 to date: Cons. Engr., Stés Hutabankova (for Russia); Stés Paris-Outreau, Arbel (in France); Sté de Montataire.

Benere Harrison Grant, Butte, Mont.
Proposed by Alfred Frank, N. B. Braley, William Huff Wagner.
Born 1889, Salt Lake City, Utah. 1903–07, Salt Lake High School. 1911, Grad., Utah School of Mines, B. S. 1911–14, Snow-Moody Development Co., Oregon Short Line R. R., U. S. Fuel Co., and Utah Fuel Co., Salt Lake City, Utah. 1914–15, Transitman, Imperial Irrigation District, El Centro, Cal. 1915, Office, General Exploration Co., Lark, Utah. 1915–17, Min. Engr., and Asst. to Supt., Ohio copper mine, Bingham, Utah. 1917–18, Supt., Bullwhacker mine, Butte, Mont.
Present position: Supt., Bullwhacker Mine & Mines Operating Co.

Leslie James Griffiths, Newcastle, N. S. W., Australia.
Proposed by H. F. Noyes, J. Jobson, David Baker.
Born 1885, Braidwood, N. S. W., Australia. 1899, Public School. 1899–1904, Broken Hill Technical College. 1901, Laboratory, Broken Hill Proprietary Co., Broken Hill, N. S. W. 1915, Asst. Chief Chem. and Chief Chem., Broken Hill Proprietary Co., Iron and Steel Works, Newcastle.
Present position: Acting Blast Furnace Supt., Broken Hill Proprietary Co.'s Iron and Steel Works, Newcastle, N. S. W., Australia.

Jean A. Hardel, Paris, France.
Proposed by A. F. Lucas, David White, Philip S. Smith.
Born 1878, Rouen, France. 1898–1900, Polytechnic School of Paris. 1900–03, French Government Highways Engineers' School. 1902, Paris Univ., B. Sc. 1904–10, Several missions in western French Africa for French Government. 1913–14, Missions in Rumanian oil fields. 1914–15, Mobilized in French Navy. 1915–17, Managing Engr., munition plant.
Present position: Counsel Engr., Société de Recherches et de Forages.

Witold Kosicki, Cambridge, Mass.
Proposed by Charles E. Locke, H. O. Hofman, Carle R. Hayward.
Born 1884, Padole, Russia. 1905–12, Institute of Emperor Alexander II, M. E. Met. plant, Satka, Ural, Russia; met. plant, Kyshtim, Russia. 1912, Met. plant, Briansk, Russia. 1913–15, summers, Asst. Met. Constr. and Engr.; Rolling Mill Dept., South Russian Met. Co. 1912–15, winters, Institute of Empress Catherine II, Petrograd, Russia. 1915–18, Munition Inspector, Russian Artillery Comm. Petrograd and U. S. A. 1918, summer, Test. Dept., Anaconda Copper Min. Co.
Present position: Student for M. S. Degree, Mass. Institute of Technology.

Manfred Theo. Hoster, St. Peters, Pa.
Proposed by Joseph T. Hilles, J. H. Devereux, H. A. J. Wilkens.
Born 1885, Wood Ridge, N. J. 1908, School of Mines, Columbia Univ., E. M. 1908–09, Practical mine work, Daly Judge Min. Co., Park City, Utah. 1909–10, Shift Boss, Alvarado Min. Co., Congress Junction, Ariz. 1910, General work, cyanide mill, Socorro Min. Co., Mogollon, N. M. 1910–12, Mech. Engr., American Smelt. & Refin. Co., Pachuca, Mexico. 1912–14, Min. Engr., Empire Steel & Iron Co., Mt. Hope, N. J.
Present position—1914 to date: Gen'l Supt., E. & G. Brooke Iron Co.

John Allan Keith Jobson, Malmberget, Sweden.
Proposed by Hugo Garde, Gustaf Wallin, Georg. Fagerberg.
Born 1883, Varberg, Sweden. 1905, Grad., Kungl. Tekn. Hogskolan, Stockholm, M. E. 1907, Magnetic surveys of iron ore, Witherbee, Sherman Iron Ore Co. 1907–08, Min. Engr., Delaware & Hudson Co., Lyon Mountain, N. Y. 1909–10, Purchasing dept., Kennedy, Sahlin Co., Brussels. 1911–13, Min. Engr., Marbella Iron Ore Co., Spain. 1913–15, Min. Capt., A. B. Kallalo, Hogheden, Calea, Sweden. 1916, Min. Engr., Luossavaara-Kiirunavaara, Malmberget.
Present position: Same as above.

Emery L. Lasier, Washington, D. C.
Proposed by Paul D. Merica, Louis J. Gurevich, C. P. Karr.
Born 1889, Washington, D. C. 1907–11, 12–13, George Washington University, A. B. 1911–12, Special work, Mass. Institute of Technology. 1907–16, Various times, Bureau of Standards, Washington, D. C. 1913, Engr. of Tests, Hydro-Electric Co. of W. Va., Chest Haven, Pa. 1912–15, Instructor, engrg. subjects, evening technical schools, Washington, D. C. 1916 to date, Asst. Material Engr., Bureau of Construction and Repair, Navy Dept., Washington, D. C. 1914 to date, Cons. Met. and Materials Engr., Washington, D. C.
Present position: See above.

Donald Hugh McDougall, New Glasgow, Nova Scotia.
Proposed by Samuel A. Taylor, Joseph W. Revere, Angus W. Macdonald.
Born 1879, St. Peters, Cape Breton, N. S. 1894, Grad., High School, Glace Bay, N. S. 1895, Government mining schools, Glace Bay. 1895–1900, International Correspondence Schools, course in mining and civil engineering. 1900–02, Dalhousie College, Halifax, Special mining courses. 1897–1899, Mine Surveyor, Dominion Coal Co., Glace Bay. 1900, Field Engr., Draftsman, Dominion Iron & Steel Co., Sydney, N. S. 1902, Asst. Resident Engr., N. Y. C. & H. R. Ry., New York. 1903, Resident Engr., D. I. S. Co., Sydney. 1904, Resident Mgr., Wabana iron ore mines,

D. I. S. Co., Newfoundland. 1908, Supt., mines and quarries, Dominion Iron & Steel Co., Sydney, N. S. 1910, Gen'l Supt. of Mines; 1911, Asst. Gen'l Mgr.; 1912, Gen'l Mgr., Dominion Coal Co., Ltd. 1916, Gen'l Mgr., Dominion Steel Corpn., including subsidiary companies.
Present position: President, Nova Scotia Steel & Coal Co., Ltd.

Fay Harrison Miller, Anaconda, Mont.
Proposed by Frederick Laist, Louis V. Bender, Charles D. Demond.
Born 1889, La Crosse, Wis. 1913, Grad., State College of Washington, B. S. 1905–06, Mine blacksmith's apprentice, Richard Mulroy, Republic, Wash. 1909, Miner, Bunker Hill & Sullivan Co., Kellogg, Ida., shoveler, miner and timberman. 1910, Miner, Bunker Hill & Sullivan Co., Kellogg, Ida., same occupations as above. 1911, Miner, Insurgent Leasing Co., Republic, Wash. 1912, Asst. Geol., U. S. Geological Survey, Washington, D. C. 1913–14, Operator and shift foreman charge oil flotation dept., zinc concentrator, Butte & Superior Copper Co., Butte, Mont. 1914–15, Shift Foreman, experimental oil flotation plant, Anaconda Copper Min. Co., Anaconda, Mont. 1915, Asst. Testing Engr., and Chem. Testing Dept., Anaconda Copper Min. Co., Anaconda, Mont.
Present position: Chief Chem., Anaconda Copper Min. Co., Anaconda, Mont.

Stalker Elijah Reed, Ojuela, Durango, Mexico.
Proposed by E. F. Salisbury, Frank J. Nagel, C. Q. Schlereth.
Born 1890, Nashua, N. H. 1908–12, Mass. Institute of Technology, B. S. 1912–13, Chem., American Smelt. & Refin. Co., Santa Barbara, Chih., Mexico. 1913–14, Engr., Oliver Min. Co., Hibbing, Minn. 1914–15, Chem., American Smelt. & Refin. Co., Santa Barbara, Chih., Mexico. 1915, Engr., Cia Minera Penoles, Ojuela, Dgo., Mexico. 1915–18, Asst. Supt., Providencia Unit, M. & M., Mexico. 1918, Acting Supt., Higueras Unit M. & M., Mexico.
Present position: Asst. Supt., Ojuela Mines, Cia Minera Penoles.

Joseph St. Germain, Anaconda, Mont.
Proposed by Louis V. Bender, F. H. Miller, Charles D. Demond.
Born 1887, Hubbell, Mich. 1906, Grad., High School, Lake Linden, Mich. 1906–10, Grad., Michigan College of Mines, E. M. 1910–12, Min. Engr., Canadian Copper Co., Copper Cliff, Ont., Canada. 1912–13, Practical mining, various companies. 1913–16, Draftsman, Anaconda Copper Min. Co., Anaconda, Mont. 1916–18, Foreman, zinc roaster plant, Anaconda Copper Min. Co., Great Falls, Mont.
Present position: Asst. Supt., Smelter, Power House, Anaconda Copper Min. Co.

Be Van Presley, Latouche, Alaska.
Proposed by J. B. Lain, Dale L. Pitt, L. W. Storm.
Born 1889, Seattle, Wash. 1910, Broadway High School, Seattle, Wash. 1914, Univ. of Washington, College of Mines. 1910–15, Various placer mines in Alaska. 1915–16, Stope Boss, Shift Boss, etc., Alaska-Treadwell Gold Min. Co., Treadwell, Alaska. 1917, Foreman, Bonanza mine, Kennecott Copper Corpn., Kennecott, Alaska.
Present position: Mill Foreman, Latouche Plant, Kennecott Copper Corpn.

Jay Emery Van Gundy, Philipsburg, Mont.
Proposed by Rush J. White, James F. McCarthy, William J. Hall.
Born 1883, Deer Lodge, Mont. 1905, Grad., Montana State School of Mines, E. M. 1905, Assayer, Kearsarge Min. Co., Virginia City, Mont. 1905–06, Assayer and Mill Supt., Crooked River Min. & Mill. Co., Orogrande, Ida. 1906–07, Draftsman and Levelman, Oregon R. R. & Navigation Co., Portland, Ore. 1907–10, Min. Engr., Federal Min. & Smelt. Co., Wallace, Ida. 1910, Asst. City Engr., Missoula, Mont. 1910–12, Mgr., Pioneer Dev. Co., San Juan Co., Utah. 1912–13, Asst. Engr., State Engineer's Office, Boise, Ida. 1913, Constr. Engr., Boise King Placers Co., Boise, Ida. 1913–16, Min. Engr., Stewart Min. Co., Kellogg, Ida. 1916–17, Mgr., Montana Manganese Co., Philipsburg, Mont.
Present position—1917 to date: Manganese Ore Purchaser, Tennessee Coal, Iron & R. R. Co.

Edward Craig Voorhees, Erie, Pa.
Proposed by D. J. McAdam, Jr., C. F. W. Rys, Hugh P. Tiemann.
Born 1878, New Brunswick, N. J. 1899, Stevens Institute of Technology, M. E. 1899–1915, Ordnance Dept., Midvale Steel Co.
Present position—1915 to date: Met., Erie Forge Co.

Edgar Stuart Ward, Eagle Pass, Tex.
Proposed by A. Leonarz, Fred B. Nold, W. G. Whildin.
Born 1882, Philadelphia, Pa. 1899, Grad., Public Schools of Philadelphia, Pa. 1900–03, Draftsman and Transitman, J. S. Sillyman & Co., Min. Engrs., Altoona, Pa. 1904–05, Engr., in charge installation of railroad and plant, Bell Jellico Coal Co., Pineville, Ky. 1905–06, Chief Engr., West Kentucky Coal Co., Sturgis, Ky. 1906–10, In business for self and as member of firm of Ward & Harper, Sturgis, Ky. 1910–12, Mech. Engr., Supt., Mexican Coal & Coke Co., Las Esperanzas, Mexico. 1912–13, Constr. Engr., Republic Iron & Steel Co., Northern Division, Republic, Pa. 1913–14, Coal prospecting, Greene Co., Pa., and general engineering practice. 1914–17, Charge Block Record Div., and Unit Costs, Highway Bureau, Philadelphia, Pa.
Present position: Chief Engr., New Sabinas Co., Ltd., Sabinas, Coah. Mexico.

Wesley Wirt Warren, Butte, Mont.
Proposed by W. C. Siderfin, John Hays Hammond, G. D. B. Turner.
Born 1875, Deerlodge, Mont. 1892, Peekskill Military Academy. 1895, Cornell Univ. 1896, British American Incorporation, Rossland, B. C. 1897–98, North Port Smelt. Co., Eastern Oregon and Idaho Districts. 1899, California Standard and Giant Oil Companies. 1900–05, Field man, Nevada Tonopah gold field and southern Nevada. 1906–14, California districts for J. B. Faraker, Jr.; and Montana capitalists. 1914–16, Asst. Engr., Revenue Cons. Gold Mines in Montana.
Present position—1916 to date: Cons. Engr., Alaska British Columbia Metals Co.

John Alexander Weir, Denver, Colo.
Proposed by P. H. Argall, Cony T. Brown, Cecil B. Hull.
Born 1884, Port Perry, Ont., Canada. 1909, Grad., Colorado School of Mines, E. M. 1909–10, Surveyman, draftsman and inspector, Arnold Co., and Denver Reservoir Irrigation Co. 1910–11, Draftsman, Goldsborough Co., Denver, Colo. 1911–12, Asst. Min. Engr., Stratton's Independence, Ltd., Victor, Colo. 1912–13, U. S. Reclamation Service, Designer of Structures, Montrose, Colo. 1913–16, Asst. Engr., Canadian Pacific Railway Co., Dept. of Natural Resources, Irrigation Branch. Charge of surveys for topography and irrigable land classification.
Present position—1916 to date: Min. Engr., Ozark Smelt. & Min. Co., Magdalena, N. M.

Lewis Gardner Westgate, Delaware, O.
Proposed by Joseph B. Umpleby, B. S. Butler, Henry G. Ferguson.
Born 1868, Phoenix, R. I. 1890, Wesleyan Univ., A. B. 1891, Harvard Univ., A. M.; 1896, Ph. D. 1891–94, Survey, northern New Jersey. 1900–18, Prof. of Geol., Ohio Wesleyan Univ., Delaware, O. 1913–18, Asst. Geol., U. S. Geological Survey. 1913–14, Mapping, Hailey, Ida.
Present position: Prof. of Geol., Ohio Wesleyan Univ.

Anthony Elmer Wickham, Fairfield, Ala.
Proposed by W. D. Armstrong, F. Tschudy, George T. Gambrill, Jr.
Born 1888, Philadelphia, Pa. 1903–06, Grad., Central Manual Training School, Philadelphia, Pa. 1906–08, Penn. State College, State College, Pa. 1908, Asst. Eng., Gulf Refin. Co., Port Arthur, Tex. 1909, Government on 25 ft. channel, Delaware River, Philadelphia to Trenton. 1909–10, B. S. R. R., Constr. Work, Resident Engr. 1910–12, Constr. byproduct coke plant as chief of party. 1912–13, Associated with W. D. Armstrong as cons. and min. engr. 1913–14, Tidewater Construction Co., const., electric railway. 1915–16, Chief Field Engr., construction benzol plant, Tennessee Coal, Iron & R. R. Co. 1916–17, Chief Field Engr., byproduct coke plant, Tennessee Coal, Iron & R. R. Co.
Present position: Supt. of Constr., 154 Byproduct Ovens Ext. to Benzol Plant, Tennessee Coal, Iron & R. R. Co.

Associates

Clarence H. Estes, Chicago Heights, Ill.
Proposed by W. S. McKee, Clement Le Boutillier, W. B. Easton.
Born 1871, High Bridge, N. J. 1888, High Bridge Public School. 1889–90, Coleman's Business College of Newark, N. J. 1900–07, Student Mechanics, Engrg. Course, Correspondence School of Mechanics, Scranton, Pa. 1890–93, Book-keeper with Hahne & Co., Newark, N. J. 1893–1905, Pattern-maker, Taylor Iron & Steel Co., High Bridge, N. J. 1905–06, Pattern-maker, Crocker Wheeler Co., Ampere,

N. J. 1906–08, Pattern-maker, American Brake Shoe & Fdy. Co., Mahwah, N. J. 1908–16, Pattern Foreman, Fdy. Supt. and Chief Inspector, American Manganese Steel Co., Chicago Heights, Ill.
Present position: Standardization Committee, American Manganese Steel Co.

David Oscar de Lima Mayer, New York, N. Y.
Proposed by Charles E. Locke, Paul R. Hayward, Frederick O. Stillman.
Born 1898, New York City. 1905–11, Public Schools of N. Y. C. 1911, Townsend Harris Hall, City College of New York. 1911–15, Horace Mann School. 1915–18, Harvard Univ., Massachusetts Institute of Technology, B. S. B. S. from Harvard to be awarded in 1919. 1915, Inspiration Extension Copper Co. 1918, Turner Concrete Constr. Co. Army Base Constr., Bay Ridge, N. J.
Present position: Awaiting induction into Government Service.

Louis Duane Simpkins, Kings Mills, O.
Proposed by W. H. Bassett, G. M. Fritch, W. M. Corse.
Born 1893, Syracuse, N. Y. 1912–16, Univ. of Colorado, B. S. 1916–17, Univ. of Colorado, M. S. Specialized in metallography, metallurgy. 1917–18, American Smelt. & Refin. Co., Murray, Utah. 1916–17, Instructor, Chemistry, Univ. of Colorado.
Present position: Chief metallurgist and chemist, Peters Cartridge Co.

Junior Associates

Jacob Stanley Fried, Youngstown, Ohio.
Proposed by William R. Chedsey, E. S. Moore, W. R. Crane.
Born 1894, Pittsburgh, Pa. 1910–14, Technical Course, Alleghany High School. 1915, Pennsylvania State College.
Present position: Student.

Joseph Hedding, Tyrone, Pa.
Proposed by William R. Chedsey, E. S. Moore, W. R. Crane.
Born 1898, Tyrone, Pa. 1915–19, Pennsylvania State College.
Present position: Student.

Kenneth V. King, Berkeley, Cal.
Proposed by Frank H. Probert, Walter S. Morley, Walter S. Weeks.
Born 1896, Great Falls, Mont. 1914, High School, Ashland, Ore. 1915 to date, Univ. of California. 1917, Laboratory Asst., Mammoth Copper Min. Co., Kennett, Cal. 1918, Inspector, Lackawanna Steel Co., Buffalo, N. Y. 1918, Chemist, Edgewood Arsenal, National Aniline Chemical Co., Buffalo, N. Y.
Present position: Student, Univ. of California.

George LeRoy Klingaman, Los Angeles, Cal.
Proposed by Frank H. Probert, Ernest A. Hersam, W. S. Morley.
Born 1898, Los Angeles, Cal. 1904–12, Public School, Los Angeles, Cal. 1912–16, Polytechnic High School, Los Angeles, Cal. 1917, Summer, Con. Virginia mine, Virginia City, Nev. 1918, Midwest Refin. Co., Denver, Colo.
Present position—1916 to date: Student, S. A. T. C., University of California.

Lenn Ping Lee, Houghton, Mich.
Proposed by A. P. Allen, F. W. Sperr, J. B. Cunningham.
Born 1894, Hong Kong, China. 1917–1918, Queen's College, St. Stephen's College, Montana State School of Mines, Michigan College of Mines.
Present position: Student, Michigan College of Mines.

William Stephen Levings, Golden, Colo.
Proposed by J. C. Roberts, Victor C. Alderson, Irving A. Palmer.
Born 1897, Denver, Colo. 1912–1916, St. Mary's College, St. Marys, Kans. 1916–18, Colorado School of Mines. 1917, 2 months, Rodman, Bonanza Min. Co., building aerial tram.
Present position: Student, Colorado School of Mines.

Edgar K. Mull, State College, Pa.
Proposed by E. S. Moore, William R. Chedsey, W. R. Crane.
Born 1898, Jeannette, Pa.
Present position: Senior Student, Metallurgy, School of Mines, Pennsylvania State College.

Edward Vincent O'Rourke, Columbus, O.
Proposed by Harry E. Nold, William J. McCaughey, Frank A. Ray.
Born 1895, Columbus, O. 1908–12, High School-Aquinas, Columbus, O. 1914–15, Notre Dame Univ., Min. Course. 1915–17, Ohio State Univ., Min. Course.
Present position—1918 to date: Min. Engrg., student, Ohio State Univ.

Clarence Watson Owings, State College, Pa.
Proposed by E. S. Moore, William R. Chedsey, W. R. Crane.
Born 1894, Gaithersburg, Md. 1914, Machinist, Auto Car Co., Ardmore, Pa. 1915, Coal Inspector, The Cons. Coal Co., Jenkins, Ky. 1916, Coal Testing Laboratory, The Cons. Coal Co., Fairmont, W. Va. 1917–18, Same as above.
Present position: Senior, Pennsylvania State College.

William Isaac Potteiger, State College, Pa.
Proposed by E. S. Moore, William R. Chedsey, W. R. Crane.
Born 1896, Reading, Pa.
Present position: Student, Pennsylvania State College.

Maurice Simon, McKees Rocks, Pa.
Proposed by William R. Chedsey, E. S. Moore, W. R. Crane.
Born 1898, New York City. 1915–19, Pennsylvania State College. 1918, Inspector, British War Mission Ordnance, McKees Rocks, Pa.
Present position: Senior student, Min. Engrg., Pennsylvania State College, Pa.

Donald Cromer Waidlich, Mercersburg, Pa.
Proposed by William R. Chedsey, E. S. Moore, W. R. Crane.
Born 1896, Mercersburg, Pa. Pennsylvania State College. General work around mine. Asst. man on engineering corps.
Present position: Student.

Paul Weir, Windber, Pa.
Proposed by William R. Chedsey, E. S. Moore, W. R. Crane.
Born 1894, Punxsutawney, Pa. 1910–16, Chainman, Map Draftsman, Berwind-White Coal Min. Co., Windber, Pa. 1917, Asst. Engr., General Engrg. Practice, Johnstown, Pa. 1918, Engr., Berwind-White Coal Min. Co.
Present position: Student, Pennsylvania State College.

Harold Ellsworth Woodlief, Buffalo, N. Y.
Proposed by J. B. Cunningham, A. P. Allen, F. W. Sperr.
Born 1892, St. Louis, Mo.
Present position: Student, Michigan College of Mines.

Change of Status—Junior to Member

Joseph T. Kupferstein, Shreveport, La.
Proposed by Charles R. Eckes, Alan Bruyere, E. W. Shaw.
Born 1892, New York, N. Y. 1898–1905, New York Public Schools. 1905–10, DeWitt Clinton High School, New York, N. Y. 1910–13 and 14–16, School of Mines, Columbia University. 1913–14, Representative, Crown Reserve Min. Co., Cobalt, Ont., Canada. 1914, Sampler, Crown Reserve mine. 1914, Representative, Caribean cobalt mine, cyanide mill. 1915, Crusherman, drill helper, miner, International Nickel Co., Copper Cliff, Ont., Canada.
Present position—1916 to date: Geol., The Texas Co.

STANDING COMMITTEES

Executive—SIDNEY J. JENNINGS, chairman.

Membership—KARL EILERS, chairman.

Finance—GEORGE D. BARRON, chairman.

Library—E. GYBBON SPILSBURY, chairman.

Papers and Publications—BRADLEY STOUGHTON, chairman.

Nominations—R. V. NORRIS, chairman.

Institute of Metals Division—WILLIAM M. CORSE, chairman; FRED L. WOLF, secretary, Ohio Brass Co. Mansfield, Ohio.

EXECUTIVE COMMITTEES OF LOCAL SECTIONS

New York—ALLEN H. ROGERS, chairman; W. S. DICKSON, secretary, 71 Broadway, New York, N. Y.
Meets first Wednesday after first Tuesday of each month.

Boston—ALFRED C. LANE, chairman; H. M. BOYLSTON, secretary-treasurer, 26 Abbot Bldg., Cambridge, Mass.
Meets first Monday of each winter month.

Columbia—S. S. FOWLER, chairman; LYNDON K. ARMSTRONG, secretary-treasurer, 720 Peyton Bldg., Spokane, Wash.
Holds four sessions during year. Annual meeting in September or October.

Puget Sound—HENRY LANDES, chairman; PERCY E. WRIGHT, secretary-treasurer, 2012 L. C. Smith Bldg., Seattle, Wash.
Meets second Saturday of each month.

Southern California—RALPH ARNOLD, chairman; ALVIN B. CARPENTER, secretary-treasurer, 530 Citizens National Bank Bldg., Los Angeles, Cal.

Colorado—CHARLES M. MACNEILL, chairman; FRED CARROLL, secretary-treasurer, State Capitol, Denver, Colo.

Montana—N. B. BRALY, chairman; E. B. YOUNG, secretary-treasurer, 526 Hennesy Building, Butte, Mont.

San Francisco—ROY H. ELLIOTT, chairman; W. H. SHOCKLEY, secretary-treasurer, 959 Waverley St., Palo Alto, Cal.
Meets second Tuesday of each month.

Pennsylvania Anthracite—R. V. NORRIS, chairman; PAUL STERLING, secretary-treasurer, Lehigh Valley Coal Co., Wilkes-Barre, Pa.

St. Louis—EUGENE MCAULIFFE, chairman; WALTER E. MCCOURT, secretary-treasurer, Washington Univ., St. Louis, Mo.

Chicago—CHARLES H. MACDOWELL, chairman; HENRY W. NICHOLS, secretary-treasurer, Field Museum of Natural History, Chicago, Ill.

Utah—WILLIAM WRAITH, chairman; F. G. MOSES, secretary-treasurer, University of Utah, Salt Lake City, Utah.

Arizona—L. O. HOWARD, chairman; H. L. NORTON, secretary-treasurer, Globe, Ariz.

Nevada—R. E. H. POMEROY, chairman; HENRY M. RIVES, secretary-treasurer, 210 Reno National Bank Bldg., Reno, Nev.

Tulsa—ALF. G. HEGGEM, chairman; JAMES H. GARDNER, secretary-treasurer, Tulsa, Okla.

Washington, D. C.—HERBERT C. HOOVER, chairman; HARVEY S. MUDD, secretary-treasurer, Room 2114, Dept. of Interior Bldg.

Mexico (Instituto Mexicano de Minas y Metalurgia.)—VICTOR M. BRASCHI, chairman, Committee on Organization.

COMMITTEE ON ARRANGEMENTS, NEW YORK (119TH) MEETING, 1919

ALLEN H. ROGERS, chairman; W. S. DICKSON, secretary.

COMMITTEE ON JUNIOR MEMBERS AND AFFILIATED STUDENT SOCIETIES

CHARLES H. FULTON, chairman; WALTER R. CRANE, secretary, Pennsylvania State College, State College, Pa.

COMMITTEE ON INCREASE OF MEMBERSHIP

J. V. N. DORR, chairman; H. C. PARMELEE, secretary, *Chem. & Met. Eng.*, 10th Ave. & 36th St., New York, N. Y.

INSTITUTE REPRESENTATIVES

United Engineering Society Trustees—CHARLES F. RAND,[2] W. L. SAUNDERS,[1] BENJAMIN B. THAYER.[3]

Engineering Foundation—R. M. RAYMOND,[1] J. W. RICHARDS, BENJAMIN B. THAYER.[3]

Library Board, United Engineering Society—ALEX C. HUMPHREYS,[3] J. H. JANEWAY,[4] E. GYBBON SPILSBURY,[1] GEORGE C. STONE,[2] BRADLEY STOUGHTON.

John Fritz Medal Board of Award—C. R. CORNING,[2] CHARLES F. RAND,[1] E. GYBBON SPILSBURY,[4] BENJAMIN B. THAYER.[3]

Engineering Council—J. PARKE CHANNING,[3] S. J. JENNINGS,[1] B. B. LAWRENCE,[1] EDWIN LUDLOW,[2] P. N. MOORE.[3]

American Association for the Advancement of Science—WALDEMAR LINDGREN, JOSEPH B. TYRRELL.

Committee on Standardization of Graphical Methods—JUDD STEWART.

Joint Committee on War Minerals—WILLIAM Y. WESTERVELT.

Committee on Mining Law Revision—JAMES R. FINLAY, D. C. JACKLING, HENNEN JENNINGS, C. F. KELLEY, EDMUND B. KIRBY.

National Research Council—P. N. MOORE.

Naval Consulting Board—WILLIAM L. SAUNDERS, BENJAMIN B. THAYER.

WAR MINERALS COMMITTEE

WILLIAM YOUNG WESTERVELT, chairman, representing A. I. M. E., and M. and M. Soc. of Am.; ALFRED G. WHITE, secretary, representing U. S. Bureau of Mines.

TECHNICAL COMMITTEES

IRON AND STEEL

JOSEPH W. RICHARDS, chairman, Lehigh Univ., So. Bethlehem, Pa.

Sub-committees

Iron Ore—DWIGHT E. WOODBRIDGE, chairman.

Blast Furnaces—H. A. BRASSERT, chairman.

Steel Works—HENRY D. HIBBARD, chairman.

Mechanical Treatment—A. A. Stevenson, chairman.

Foundry—RICHARD MOLDENKE, chairman.

Chemistry, Physics, and Metallography—HERBERT M. BOYLSTON, chairman.

---

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921. [4] Until Feb., 1922.

Petroleum and Gas

Anthony F. Lucas, chairman; Isaac N. Knapp, secretary.

Coal and Coke

Samuel A. Taylor, chairman; William E. Fohl, secretary, Farmers' Bank Bldg., Pittsburgh, Pa.

Precious and Base Metals

Charles W. Goodale, chairman; Darsie C. Bard, secretary, Montana State School of Mines, Butte, Mont.

Sub-committees

Copper—Edward P. Mathewson, chairman.
Gold and Silver—F. Lynwood Garrison, chairman.
Lead—Heinrich O. Hofman, chairman.
Zinc—George C. Stone, chairman.
Miscellaneous Metals—Charles H. Fulton, chairman.
Placer Deposits—Charles Janin, chairman.

Non-metallic Minerals

Heinrich Ries, chairman; William C. Phalen, secretary, U. S. Bureau of Mines, Washington, D. C.

Mining Geology

John W. Finch, vice-chairman; L. C. Graton, secretary, Harvard Geological Museum, Cambridge, Mass.

Mining Methods

Robert M. Catlin, chairman; Benjamin F. Tillson, secretary, Franklin Furnace, N. J.

Milling Methods

Robert H. Richards, chairman; Charles E. Locke, secretary, Mass. Institute of Technology, Boston, Mass.

Mining Law

Cornelius F. Kelley, chairman.

The Use of Electricity in Mines

William Kelly, chairman.

Industrial Organization

T. T. Read, chairman.

Sub-committees

Americanization—Hennen Jennings, chairman. (To coöperate with National Americanization Committee.)
Cripples in Industry—B. A. Robinson, chairman. (To coöperate with the Surgeon General, U. S. A., and the Red Cross Institute.)
Education—E. E. Bach, chairman. (To coöperate with National Association of Corporation Schools.)
Employment—H. M. Wilson, chairman. (To coöperate with U. S. Department of Labor.)
Housing—C. R. Hook, chairman. (To coöperate with National Housing Association, and U. S. Dept. of Labor.)
Mental Hygiene in Industry—T. T. Read, chairman. (To coöperate with National Committee for Mental Hygiene.)
Prevention of Illness—H. I. Young, chairman. (To coöperate with American Public Health Association, etc.)
Safety—B. F. Tillson, chairman. (To coöperate with National Safety Council.)
Social Surveys—C. W. Goodale, chairman. (To coöperate with Russell Sage Foundation.)

OFFICERS AND DIRECTORS

For the year ending February, 1919

PRESIDENT

SIDNEY J. JENNINGS, ... NEW YORK, N

PAST PRESIDENTS

L. D. RICKETTS, ... NEW YORK, N
PHILIP N. MOORE, ... ST. LOUIS,

FIRST VICE-PRESIDENT

C. W. GOODALE, ... BUTTE, M

TREASURER

GEORGE C. STONE, ... NEW YORK, N

SECRETARY EMERITUS

ROSSITER W. RAYMOND, ... NEW YORK, N

SECRETARY

BRADLEY STOUGHTON, ... NEW YORK, N.

VICE-PRESIDENTS

KARL EILERS,[1]	District 0	NEW YORK, N
JAMES MACNAUGHTON,[1]	District 4	CALUMET, M
CHARLES W. GOODALE,[2]	District 5	BUTTE, M
MARK L. REQUA,[2]	District 6	SAN FRANCISCO,
HENRY S. DRINKER,[3]	District 2	SO. BETHLEHEM,
ROBERT M. RAYMOND,[3]	District 0	NEW YORK, N

DIRECTORS

GEORGE D. BARRON,[1]	District 0	NEW YORK, N
EDWIN LUDLOW,[1]	District 2	LANSFORD,
CHARLES F. RAND,[1]	District 0	NEW YORK, N.
THOMAS B. STEARNS,[1]	District 7	DENVER, C
B. B. THAYER,[1]	District 0	NEW YORK, N.
J. E. JOHNSON, JR.,[2]	District 0	NEW YORK, N.
ALLEN H. ROGERS,[2]	District 1	BOSTON, M
HOWARD N. EAVENSON,[2]	District 9	GARY, W.
J. V. N. DORR,[2]	District 0	NEW YORK, N.
WILLET G. MILLER,[2]	District 11	TORONTO, CAN
FREDERICK G. COTTRELL,[3]	District 6	SAN FRANCISCO, C
HENNEN JENNINGS,[3]	District 9	WASHINGTON, D
GEORGE C. STONE,[3]	District 0	NEW YORK, N.
SAMUEL A. TAYLOR,[3]	District 2	PITTSBURGH,
ARTHUR THACHER,[3]	District 3	ST. LOUIS,

[1] Until Feb., 1919. [2] Until Feb., 1920. [3] Until Feb., 1921.

All communications in reference to applications should be addressed to THE SECRETARY, AMERICAN INSTITUTE OF MINING ENGINEERS, 29 West 39th Street, New York

American Institute of Mining Engineers

APPLICATION

I, ______________________________
(Give name in full: initials not sufficient.)

residing at ______________________________ *, desire*
(Give an address at which you may be reached during the next four months)

to be { *admitted* / *transferred* } *as* ______________ *in the American Institute*
(Member; Associate; Jun. Assoc.)

of Mining Engineers, and submit the following as my professional record:

I was born at ______________ *on* ______________.
(Place and date of birth)

and am a citizen of ______________________________

I was educated at
(A technical education is not requisite for membership.)

School or College	Dates

I graduated in ______________ *, and received the degree of* ______________
(Date)

____
____
____

Signature of three Members or Associates

If you wish the Institute to secure the necessary signatures please give below the names of at least five members or associates with whom you are acquainted. A list of members will be sent on application.

I refer to the following Members or Associates

Give the names of at least five Members or Associates.

This information need not be given if three members or associates sign the proposal blank.

____
____
____
____
____

The initiation fee for Members and Associates is $10, in addition to which the annual dues for the current calendar year are $12. The yearly dues of Junior Members are $5, and they pay no initiation fee until transferred to another grade of membership. The annual dues for the current year are payable upon election.

REQUIREMENTS FOR MEMBERSHIP

Extract From Constitution

ARTICLE II

Members

Sec. 1. The membership of the Institute shall comprise four classes, namely: 1. Members; 2. Honorary Members; 3. Associates; 4. Junior Associates.

All members shall be equally entitled to the privileges of membership, excepting that Honorary Members, Junior Associates, and Members and Associates whose residences shall be outside of the United States, Mexico, and Canada, shall not be entitled to vote. Members and Associates residing within the United States of America, Mexico, and Canada, and not in arrears for dues, shall be entitled to vote in person at the meetings of the Institute, or, as hereinafter provided for, by letter ballot.

Sec. 2. MEMBERS shall comprise all those persons who on the third Monday of February, 1918, were members of the Institute, and in addition thereto, all those thereafter elected or transferred into the class of Members.

MEMBERS must be at least 27 years of age and must have had at least six years' employment in the practice of engineering, mining, geology, metallurgy or chemistry, during at least three years of which they must have held positions of responsibility in one or more of these fields.

Graduation from the scientific course of a college, approved by the Committee on Membership, shall be considered equivalent to two years' employment, as required in the previous sentence.

Employment as a teacher of engineering, mining, geology, metallurgy or chemistry, if in direct charge, may be considered a position of responsibility as specified in the second preceding paragraph.

Persons employed in research or any scientific literary work or in teaching in the scientific departments of colleges, approved by the Committee on Membership, who at the same time are engaged in consulting or in the active practice of mining, geology, or metallurgy, shall be entitled to consider the time so spent in active practice as equivalent to an equal length of time of employment in positions of responsibility, provided the work done or the positions held seem to the Committee on Membership to warrant the equivalency.

The requirement of three years' employment in positions of responsibility may be waived by the Committee on Membership in the case of persons who have done notable original work in mining, geology, or metallurgy, or have won distinction by research or investigations in one or more of these subjects. By investigation or research is understood laboratory experimentation as distinct from investigations in literature or compilations of the work of others.

ASSOCIATES shall be those who, in the opinion of the Committee on Membership and the Board of Directors, are suitable for such election or transfer by reason of their interest in or connection with mining, geology, metallurgy, or chemistry.

JUNIOR ASSOCIATES shall comprise all students in good standing in engineering schools, who have not taken their degrees and are nominated by at least three members, two of whom must be their instructors. A Junior Associate may remain such not longer than five years after leaving the engineering school, at the end of which period his qualifications to become a Member or Associate must be passed upon by the Committee on Membership. If elected he shall pay at that time the entrance fee and dues of a Member or Associate.

In case there is any question as to the classification of a candidate the Committee on Membership may require from him any evidence he desires to present and the decision of the Committee as to the proper status shall be final.

Every candidate for election as a Member, Associate, or Junior Associate must be proposed for election by at least three Members or Associates, must be approved by the Committee on Membership, as prescribed in the By-Laws, and must be elected by the Board of Directors.

The Engineering Work of the National Research Council

BY HENRY M. HOWE*

(Milwaukee Meeting, October, 1918)

1. *The purpose* of the National Research Council as organized for war purposes is twofold, to stimulate those outside its own personnel to conduct researches of importance for winning the war and to carry on such researches through its personnel to a limited extent. How this is done is explained in Section 10. "Research" is used here in a very broad sense, including, for instance, inventing and developing mechanical and physical devices.

The need of this work arises from the inevitable concentration of most of the governmental war agencies on the production and transportation of war materials of the types now adopted, as distinguished from devising new kinds of instrumentalities, such as armor, guns, aircraft, and apparatus for detecting, locating, observing, signaling, transporting, and many other military purposes. But it is important that we should devise new agencies. The war came near being won by an invention, the submarine, and its course has been affected greatly by two other inventions, tanks and aircraft. In spite of our numerical superiority victory may well be snatched from us by an invention, if we allow Germany to outstrip us in inventing. Hence the importance of the Council's work in mobilizing and organizing the services of the patriotic civilian experts throughout the country, so as to bring their powers to bear on important war problems and on inventing war devices, as an adjunct to the development work of the regular governmental bodies.

2. *Status of the Council.*—Though President Wilson's request caused the Council to be created by the National Academy of Sciences under its congressional charter in 1916; though his executive order of May 11, 1918, directs the heads of "Governmental departments immediately concerned" to "continue to co-operate with it in every way that may be required;" and though the Government has contributed largely to its financial support (Section 12, page 10), it is not a department of the Government but an independent research body, aiming to evolve the necessary mechanism for the novel work of systematic stimulation and guidance of research. Thus the Government, which instigated the creation of the Council, recognizes and collaborates with it, and in part supports it.

The Council acts moreover as the Department of Science and Research of the Council of National Defense.

---

* Chairman of the Division of Engineering of the Council.

3. *The war organization* consists of nine divisions, as follows:

I. Division of General Relations.
II. Military Division.
III. Division of Engineering.
IV. Division of Physics, Mathematics, Astronomy, and Geophysics.
V. Division of Chemistry and Chemical Technology.
VI. Division of Geology and Geography.
VII. Division of Medicine and Related Sciences.
VIII. Division of Agriculture, Botany, Forestry, Zoology, and Fisheries.
IX. Research Information Service.

4. *The Organization of the Division of Engineering.*—It is made of four sections as follows:

1. Prime Movers. L. S. Marks, *Chairman.*
2. Mechanical Engineering. W. J. Lester, *Chairman.*
   Committee:
      Fatigue of Metals. H. F. Moore, *Chairman.*
3. Metallurgy. Bradley Stoughton, *Chairman.*
   Committees:
      Helmets and Body Armor. Major Bashford Dean, *Chairman.*
      Ferro-Alloys. J. E. Johnson, Jr., *Chairman.*
      Steel Ingots. Lt. Col. W. P. Barba, *Chairman.*
      Pyrometer. George K. Burgess, *Chairman.*
      Improvement of Metals by Treatment at a Blue Heat. Zay Jeffries, *Chairman.*
4. Electrical Engineering. C. A. Adams, *Chairman.*
      Committee jointly under Metallurgy and Electric Engineering; Electric Welding and Ships. H. M. Hobart, *Chairman.*

We expect to organize additional committees in the near future.

These sections are directed by an Executive Committee consisting of the Chairman of the Division and of the four Sections.

In addition there is an Advisory Committee consisting of:

Van H. Manning	Officially representing the	U. S. Bureau of Mines.
Pope Yeatman		War Industries Board.
D. W. Brunton		Naval Consulting Board.
Ambrose Swasey		Engineering Foundation.
George S. Webster		American Society of Civil Engineers.
Philip N. Moore		American Institute of Mining Engineers.
John R. Freeman		American Society of Mechanical Engineers.
C. A. Adams		American Institute of Electrical Engineers.
A. A. Stevenson		American Society for Testing Materials.
W. B. Price		American Institute of Metals.
Edward P. Hyde		Illuminating Engineering Society.

W. H. Burr	Members at large.
Gano Dunn	
George C. Stone	
W. R. Walker	
F. M. Waring	
L. B. Stillwell	

The Advisory Committee meets at intervals to direct the general policy of the division. All the other committees are actively engaged on their several problems, though one of them has been delayed by illness and other complications.

5. *The sources of our problems* are very varied. Some come from various governmental bodies, some from the industries and the engineering societies, some from inventors and the general public, and some from our own staff.

Problems and projects the solution and development of which promise to be useful either for war or peace, for industry or for science, are our grist. By sending them to us this Institute and the engineering profession in general will enable us to broaden our service to them, and indeed to mankind. So, too, we welcome offers of coöperation from professional experts, whether through work done in their libraries and laboratories, through sending us important data, or otherwise.

6. *Researches by Experts Outside of our Personnel.*—Let me illustrate these by means of certain researches which the Section of Metallurgy has in hand.

The winning of the war is retarded appreciably by the delay caused by the rejections in making certain important kinds of forgings, such as shells, crankshafts, cannon, etc. These rejections are due chiefly to faulty procedure in making and forging the steel ingots themselves. The faultiness exists because the rapid increase in the demand for such ingots has led many into this manufacture without sufficient experience. The problem thus is "How can we bring the procedure of the relatively inexperienced up to that of the best makers?" We are trying to solve it by means of our Steel Ingot Committee, composed of men who are recognized by all as among the most capable experts on this subject in the world, under the chairmanship of Lieutenant-Colonel W. P. Barba, himself one of the highest authorities. It contains representatives of the Ordnance Department, the Bureaus of Standards and of Mines, Bethlehem, Midvale, the United States Steel Corporation, the Illinois Steel Company, the Crucible Steel Company of America, and the Standard Steel Company. We may strengthen this committee still farther by adding to it French and British experts of like eminence.

We expect this committee to prepare a set of detailed directions constituting "Recommended Practice." Appearing over names of such weight it should immediately become standard. Its existence should not only instruct the manufacturers needing instruction, thus reducing the personal equation to a minimum, but also strengthen the hands both of those drawing up contracts and of the inspectors who enforce them. Moreover it should do this at one motion for all branches of the Government.

7. *Pyrometry.*—One of the points on which definite instruction should be given for this very matter of ingot making is the temperature of the

molten metal in the open-hearth and electric steel furnaces. Because no pyrometer for determining this temperature exists, a necessary step in our evolution is to devise one. This, though in part a question of pyrometry, is also in large part one of refractory materials.

To solve this problem a committee has been formed under the chairmanship of Dr. George K. Burgess, of the Bureau of Standards, and with representatives of Leeds & Northrup for pyrometry; of the Norton Company, the Joseph Dixon Crucible Company, and the Harbison-Walker Refractories Company for refractory materials; and of the Midvale Steel and Ordnance Company and the Taylor Wharton Iron and Steel Company for steel making. These two steel making companies have placed their open-hearth and electric furnaces at the disposal of the committee for this work.

8. Our other committees are working in like manner on problems of immediate importance for war-winning. Thus the Committee on the Fatigue of Metals, under Professor H. F. Moore, of the University of Illinois, is directing its study toward the endurance of aircraft crankshafts and of the electric welds in welded ships. That on Ferro-alloys, under J. E. Johnson, Jr., is studying the saving of manganese along three distinct lines, that of bringing the work of the least successful smelters up to that of the most skillful ones, that of replacing part of the manganese used in steel making with other deoxidizing agents, and that of lowering the manganese requirements of existing engineering specifications.

This work incidentally calls for the determination of many melting points of the combinations of oxides resulting from the substitution of other deoxidizing agents for manganese. A large number of research laboratories at many educational institutions and industrial works are collaborating in this difficult work.

This general study is carried on jointly by this committee and the United States Bureaus of Mines and of Standards and the Geophysical Laboratory.

The study of the treatment of metals at a blue heat is in the hands of a committee headed by Dr. Zay Jeffries, Director of the Research Department of the Aluminum Castings Company, which has contributed so much to the development of our aircraft. This difficult study promises results of great value.

9. *Electric Welding.*—The Committee on the Electric Welding of Ships, under the chairmanship of Mr. H. M. Hobart of the General Electric Company, is making an exhaustive study of the technical and especially the metallurgical problems which arise in substituting electric welding for the customary riveting of steel ships. It is a division of the Electric Welding Committee of the Emergency Fleet Corporation. Its investigations are carried on at many different works and laboratories, notably those of the General Electric Company and the Bureau of Standards.

10. *Researches by our own personnel* are illustrated by the Section of Mechanical Engineering, under Chairman Lester. It has long had its own engineers and draftsmen, and it now has in addition the laboratories and machine shop of the Carnegie Institute of Pittsburgh. By means of these the rather nebulous but attractive inventions offered us are developed in coöperation with the Division of Physical Sciences, into definite concrete form, in which the military authorities may judge quickly as to their present and future utility. In some cases we complete the apparatus fully enough for actual service tests.

Among the inventions which this section is now developing, in part in coöperation with the Division of Physics, are these:

1. A special gun for use on aircraft.
2. A special drive connected with it.
3. Control for aircraft.
4. Aircraft propellers.
5. Aircraft fuel.
6. Tanks of various types.
7. Mechanism for the control of trucks.
8. Special type of tractors.
9. Special telescopes.
10. Special balloons.
11. Parachutes.
12. Special aircraft motors.

Military considerations prevent indicating more closely the nature of these inventions.

The stages in which these devices now are vary all the way from preliminary design to nearly complete readiness for production.

In addition we have before us many other promising proposals which we cannot develop for lack of funds.

11. *Government Support.*—In some cases, after we have shown clearly enough that a given invention is of real promise, we receive an appropriation from some military or other governmental body to enable us to carry the development still farther. In other cases the research is taken over by some governmental body. Thus the work of the Committee on Helmets and Body Armor was taken over by the Ordnance Department many months ago, and is still carried on by that organization and the Council jointly, its chairman, Dr. Bashford Dean, being commissioned as a major. This accords with our general aim of originating and stimulating research. We shall accomplish more in the end if we leave to others the completion of the researches which we have led them to undertake. Our work is not so much to investigate as to cause investigation, cheerfully forfeiting the credit due the investigator proper. So, too, a device may be materially changed after it leaves our hands.

The Constitution of the Tin Bronzes

BY SAMUEL L. HOYT,* MINNEAPOLIS, MINN.

(Milwaukee Meeting, October, 1918)

THE writer has long been interested in seeking an explanation of the upper heat effect in the copper-tin alloys over the $\alpha + \beta$ range, first described in 1913. These notes are offered, not at all as the final explanation of this heat effect, but rather to indicate certain progress which has been made toward establishing what happens over this temperature interval.

While working on the thermal analysis of the copper-rich kalchoids (copper-tin-zinc alloys), it was noted that those alloys containing major portions of tin and minor portions of zinc exhibited two marked heat effects, one at about 520° C. and the other at about 600° C., instead of the single effect which is generally observed in either of the two binary series. This matter was discussed with Dr. Guertler, who suggested that a heat effect at about 600° C. in the pure copper-tin alloys might be expected. This led to a more searching examination of the thermal critical points in the pure copper-tin alloys, with the result that a marked, although somewhat weak, heat effect was located at about 600°. Somewhat later, this upper heat effect was discussed with Dr. Burgess, and it was requested that the Bureau of Standards make heating and cooling curves of one of these alloys for the purpose of removing any possible doubt as to the actual presence of the heat effect. Results obtained by the Bureau are given in Plate I.

In an earlier paper[1] differential curves were published showing that the heat effect occurred at constant temperature over the $\alpha + \beta$ range and increased in magnitude with the amount of β up to a point somewhat above 20 per cent. tin. No heat effect was noticed at this temperature in the eutectoid alloy.

The existence of this heat effect seems to require a modification of the present copper-tin diagram in the $\alpha + \beta$ field, and it has been the object of the work here presented to secure the evidence upon which such a change should be based.

---

* School of Mines, University of Minnesota.

[1] S. L. Hoyt: On the Copper-rich Kalchoids. *Jnl.* Inst. Metals (No. 2, 1913) **10**, 235.

Inasmuch as this upper heat effect is much more marked in the ternary alloys, and is probably due to the same cause, a small bar, 4 in. (10.16 cm.) long, of an alloy 75 Cu, 15 Sn, 10 Zn, was heated over its entire length to a temperature of about 700° C., or well above the upper heat effect. The bar was then slowly moved along to the cooler portions of the furnace, and finally partially removed from the furnace so as to cause the temperature of one end to fall gradually from 700° C. to

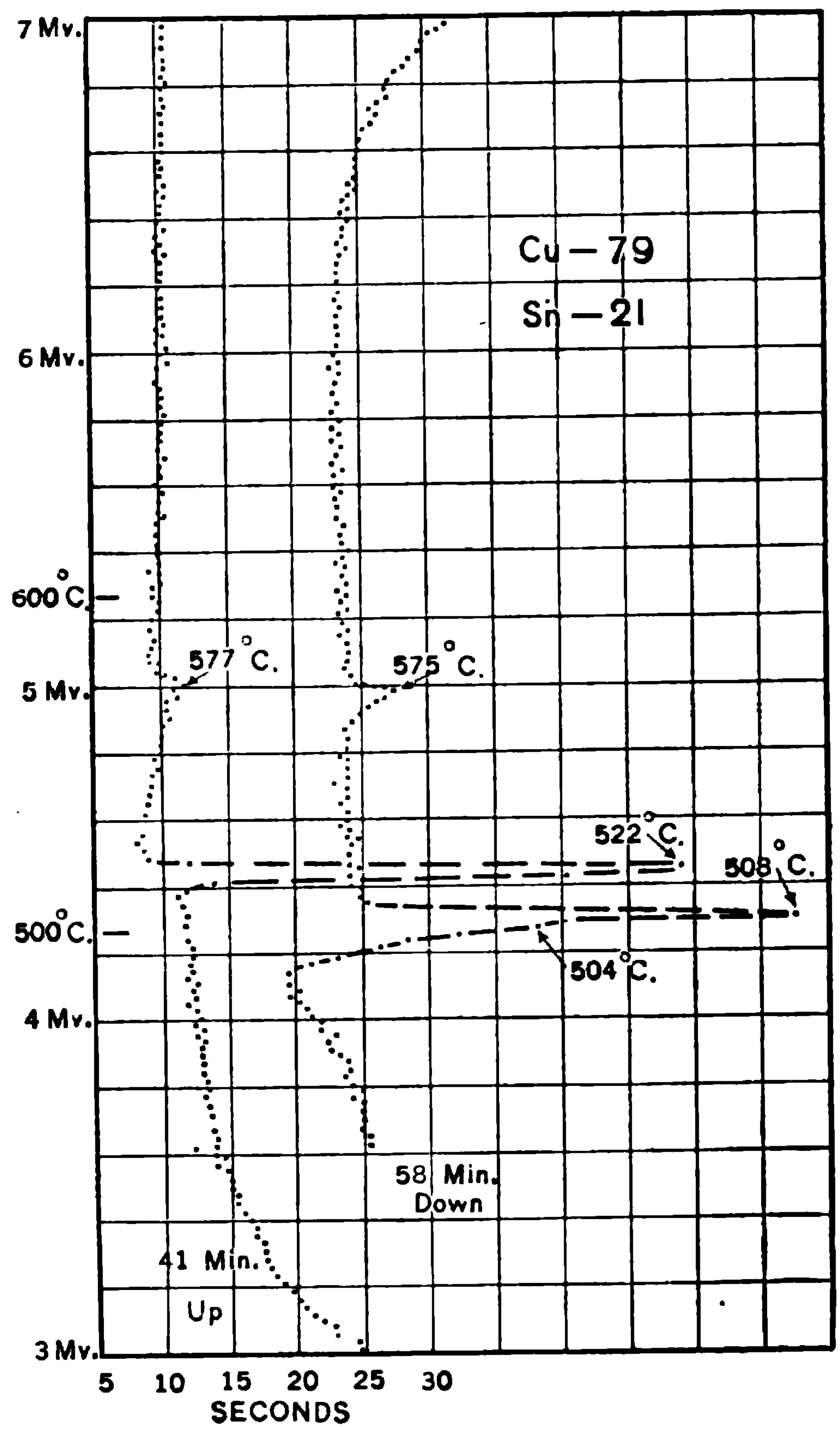


PLATE I.

about 400° C., while the temperature of the other end remained about as before. The bar was held in this condition for 8 hr. and then suddenly quenched in cold water. One side was ground down, polished, and etched with ferric chloride.

As was expected, the complete transition from the high- to the low-temperature modifications could be observed. These are reproduced in Fig. 1 to 6. Fig. 1 shows the high-temperature modifications, which may be called α and β. At a position corresponding to a somewhat

FIG. 1.—HOT END.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.—COOL END.

FIG. 1–6.—ALLOY 75 CU, 15 SN, 10 ZN. ETCHED WITH FERRIC CHLORIDE. × 800.

lower temperature, a well defined reaction rim is formed between α and β. At a still lower temperature this reaction rim has grown somewhat, while smaller crystals of the new phase have formed at the central parts of the original β constituent. While this new phase has the appearance of being a reaction rim, it must be conceded that proof that it is such is yet lack-

Fig. 7.—$\times$ 100. Fig. 8.—$\times$ 800.

Fig. 7–8.—Alloy 79 Cu, 21 Sn. Quenched from above upper heat effect. Etched with ferric chloride.

Fig. 9.—Etched with ferric chloride. $\times$ 100. Fig. 10.—Etched with cupric chloride. $\times$ 800.

Fig. 9–10.—Alloy 79 Cu, 21 Sn. Quenched from between the upper and lower critical points.

ing. At a position still further toward the cold end, we find additional complication in the succession of phases. The reaction rim has encroached still further upon the original β constituent but, in turn, has given way to a fourth phase which, like the third, is light gray in color, the α being yellow and the β being brown, on etching with ferric chloride. The four phases are shown very clearly in Fig. 4.

In Fig. 5, which shows a field still further toward the cold end, we find the beginning of the formation of the eutectoid structure, with the last traces of the original reaction rim, or possibly, in exceptional cases, of

Fig. 11.—Alloy 75 Cu, 25 Sn. Quenched from above the upper critical point. Etched with Rosenhain's reagent. × 75.

Fig. 12.—Alloy 75 Cu, 25 Sn. Quenched from between the upper and lower critical points. Etched with cupric chloride. × 100.

the original β. Apparently, at this point, what was originally the reaction rim changes over into the eutectoid. At a point slightly nearer the cold end, as in Fig. 6, we find the normal structure of the slowly cooled

Fig. 13.—Alloy 75 Cu, 25 Sn. Quenched from between the upper and lower critical points. Etched with cupric chloride. × 800.

Fig. 14.—Alloy 75 Cu, 25 Sn. Etched with ferric chloride. × 800.

alloy, except that, instead of there being three generations of α, there are now only two, presumably the first and the second.

It would do little or no good to attempt to analyze the structural

changes from the point of view of the phase rule, inasmuch as we are quite evidently not dealing with stable equilibria. As an explanation of the two well defined heat effects exhibited by this alloy, these photographs also offer little that is enlightening. Thus it seems apparent that the tin-rich constituent of the eutectoid may make its appearance prior to the actual formation of the eutectoid, which certainly is not in accordance with our ideas of eutectoid formation.

Two pure copper-tin alloys, one containing a considerable proportion of excess α and the other only a slight amount, were quenched in water from above the upper critical point and from between the upper and lower critical points respectively. The results obtained are shown in Fig. 7 to 13. Fig. 7 and 8 show the customary α and β phases. Fig. 9 and 10, except for the larger amount of α, show the same structure, *i.e.*, $\alpha + \beta$. Fig. 10 shows the effect of etching with cupric chloride, which reverses the action of ferric chloride and attacks the α instead of the β. A similar structure is obtained by preliminary heating to above the upper critical point prior to holding the temperature constant between the critical points.

In the course of this work, a fair idea of the conditions which lead to the formation of the second and third generations of α has been obtained. These two generations, both found in eutectoid structures, were described in the paper already referred to, the alloy being a ternary alloy of copper, tin and zinc. The same occurrence in the binary copper-tin alloys is shown in Fig. 14.

Discussion

Paul D. Merica,* Washington, D. C. (written discussion†).—Investigation that has for its purpose the determination of the constitution of the alloys of copper with tin and with zinc is not only of much scientific interest, but will serve a very practical purpose as well. The constituents, with which the anomalous heat effects discovered by the author are undoubtedly associated, are to be found in commercial brasses and bronzes, and can exert a profound effect upon their mechanical properties, although present in relatively small proportion.

Thus in a recent article[1] it was shown that a sample of commercial naval brass rod, which normally consists of α and β grains, developed envelopes of the so-called δ constituents around the β grains upon heating to 330° to 430° C. The effect of this new constituent upon the tensile properties of the rod was most striking; the elongation in 2 in. was reduced from about 35 per cent. to from 21 to 26 per cent.

---

* Metallurgist, U. S. Bureau of Standards.

† Received Oct. 8, 1918.

[1] P. D. Merica and L. W. Schad: Thermal Expansion of Alpha and of Beta Brass. *Jnl.* Am. Inst. Metals (1917) **11**, 396.

It is therefore apparent that in wrought brasses of similar composition, containing tin, there is the very unpleasant possibility of developing this δ constituent by annealing, and thus spoiling the material. It becomes, thus, a matter of the utmost importance to determine the temperature limits of the appearance and disappearance of this constituent, and indeed to clear up the whole vexing question of its identity and relation to the constitution of the ternary alloy system.

A most significant feature of this δ constituent is its development, possibly as a peritectoid at the edge of the β grains, forming a brittle envelope around them. It is undoubtedly a constituent to be avoided if possible, although I have tested wrought brass containing it in granular form, which was of most excellent mechanical properties.

I should like to ask the author whether he is aware of the existence of this constituent in commercial casting bronzes, such as the well known 88-10-2 bronze, and of its effect upon the mechanical properties of such bronze.

I am most interested in this line of work and shall hope that the author will not overlook the practical application of it.

A Symposium on the Conservation of Tin

(Milwaukee Meeting, October, 1918)

CONTENTS

Bronze Bearing Metals

G. H. CLAMER,* PHILADELPHIA, PA.—Unfortunately, prior to the war no serious attention was given to the conservation of tin, notwithstanding that this country is practically dependent upon outside sources for its entire tin supply.

Tin is of vital importance in many industries, but it is surprising how many and how excellent are its substitutes when we become acquainted with them. Tin has always been a relatively high-priced metal, and it is part of the human attitude to associate high prices with high standards; it is not until the price of a commodity becomes well-nigh prohibitive that we hunt for substitutes, because the idea of substitution seems always to involve an assumption that the substitute must necessarily be inferior.

The history of the development of bearing bronzes is a striking example of this policy. In the early days, copper-tin alloys were almost universally used, the idea then being prevalent, which is still held by many, that a bearing to resist wear must be hard, and the harder the better. The favorite bronze bearing contained 90 per cent. copper and 10 per cent. tin; frequently, in service which was considered severe, even higher proportions of tin were used. Such hard alloys have great resistance to compression, but as a rule they had a very wide factor of safety in this

* First Vice-president and Secretary, Ajax Metal Co.

respect. Such bearings, because of their inability to adjust their surfaces to slight irregularities in the journal, or to foreign bodies, immediately begin to cut, and heating results. With a slight rise in temperature, the film of lubricant becomes thinner, and further cutting follows, if not actual gripment of the bearing with the journal.

Many years ago, Dick, of England, appreciating the advantage to be derived from a slight plasticity in a bearing, added some lead to the then standard bearing metal, not substituting lead for tin but reducing the copper, and produced the alloy which has long held favor as a bearing metal, *i.e.*, copper, 80; tin, 10; lead, 10 per cent. Dick's alloy also contained some phosphorus, but the main point is that this was the first step toward the production of bronze alloys having a plastic nature. Lead does not unite to form an alloy with copper, but remains mechanically mixed, so that the structure of the alloy is that of a hard matrix with the soft metal imbedded therein.

It was not until several years later that tests were conducted on the Pennsylvania Railroad, under the direction of Dr. C. B. Dudley, who investigated the copper-tin-lead series within certain limits of the 80-10-10 alloy; he studied not only the alloys containing lead above 10 per cent. in which copper was replaced by lead, but also in which tin was replaced by lead. His conclusions, which have since become firmly established, are: (1) The rate of wear diminishes with increase of lead in the alloy. (2) The rate of wear diminishes with decrease of tin in the alloy. Fortunately, the alloy containing least tin and highest lead exhibits least tendency, in service, to give trouble from heating.

Notwithstanding the decided merit of copper-tin bearings containing lead, prejudice was strongly against them, simply because lead is a low-priced metal. It was even intimated that such alloys were frauds, should be considered such, and dealt with accordingly.

I have mentioned Dr. Dudley's discoveries because it was due to his findings that we instigated research work, now 20 years ago, which has led to the production of alloys still higher in lead and lower in tin than those which he was able to produce. He experienced foundry difficulties which apparently limited his maximum-lead alloy to 77 copper, 8 tin, and 15 lead. This was called Experiment B alloy, and has since been widely known as "Ex. B metal."

Having due regard to the raw materials used, and by following good foundry practice, we have been able to produce alloys carrying 5 per cent. of tin and as much as 30 per cent. of lead which would show no segregation of lead, even if cast into large bearings. By this I mean that such bearings will show no indication of metallic lead upon any surfaces. Lead being only mechanically held in the alloy, it is prevented from segregating only by the quick setting of the matrix of copper and tin. As a certain interval must necessarily occur between the time when the metal

enters the mold and the time when it solidifies, the lead always shows some tendency, owing to its high specific gravity, to liquate toward the bottom of the casting. In bearings made of the pr0per raw materials, and correctly handled, the difference in the proportion of lead is not usually over a fraction of 1 per cent., or at most 2 or 3 per cent., between the top and the bottom of a casting, even if this be a fairly large one, and made of the 30-per cent. lead alloy.

I do not wish to repeat here data which I have given in previous papers[1] but I do wish to set forth the position which the high-lead and low-tin alloys developed by us have attained. When these alloys were first produced they were backed only by laboratory tests and by the predictions of Dr. Dudley that, if such alloys could be commercially produced, the law which he established would no doubt apply also to alloys higher in lead and lower in tin than those which he had developed. It is now possible for me to review 18 years' experience with the manufacture and service of such bearings. I must confess that in our enthusiasm over the valuable properties of these alloys, we were led at times to overstep the mark and place such bearings in service where the loads or the impacts were too great.

The first requisite of a bearing is that it shall be sufficiently hard to support its load or to resist the impacts to which it may be subjected, and the relation of tin to lead must be controlled by this requirement. We have sometimes made mistakes in recommending the copper 65, tin 5, lead 30 alloy for certain mill bearings; this did not have sufficient resistance to compression, and failed for that reason. When the copper 73, tin 7, lead 20 alloy was substituted, the bearings exhibited no deformation and performed far better than the 80-10-10 alloy previously used. We have also noted the failure of the 73-7-20 alloy on rod bearings of very heavy locomotives. Locomotive rod bearings are subjected to severe impacts and it is necessary therefore to use an alloy of fairly high compressive strength. Although the above alloy performs satisfactorily on light locomotives, on the rod bearings of heavy locomotives it is necessary to use either the 80-10-10 alloy or the same alloy to which has been added approximately 1 per cent. of phosphorus. The size of these bearings, and hence their bearing surface, is narrowly limited by necessities of construction; otherwise these harder alloys would not be essential for this purpose. Phosphorus greatly increases the compressive strength of such an alloy, and is for this reason a possible factor for conserving tin. At the present prices of tin and phosphorus there is little choice;

[1] For example: A Study of Alloys Suitable for Bearing Purposes. *Jnl.* Franklin Inst. (July, 1903) **156**, 49. History and Development of the Alloy Practice in the United States as Applied to Railway Bearings. *Proc.* Amer. Soc. Testing Materials (1907) **7**, 302. Effect of Changes in the Composition of Alloys Used by the American Railways for Car-journal Bearings. *Trans.* Am. Inst. Metals (1915) **9**, 241.

an alloy with 8 per cent. of tin and 1 per cent. of phosphorus will have compressive strength approximately equivalent to the alloy having 10 per cent. tin. Experience, thus, has demonstrated that alloys containing as little as 5 or even 4 per cent. tin and as high as 30 per cent. lead, can be used in railroad service for car bearings. They have become the standard of the United States Railroad Administration for car-journal bearings called for under their Specifications R-71, Grade A. Such an alloy is also included in the specifications covering locomotive bearings designated as Specification R-72, Soft Bronze.

In my judgment, the specifications of the Railroad Administration covering locomotive bearing-metals are very satisfactory, except that the use of soft bronze should be extended to cover driving brasses, and engine and trailer-truck bearings. Before the railroads of the United States came under Government control, copper alloys with low-tin and high-lead contents had become the standard specifications of several of the large car companies, and were very extensively used on the largest railroad systems. Outside of the railroad field they had also been widely recognized and used. The advantage of using the smallest possible amount of tin consistent with the load requirements is now so well understood that there is but little opportunity for an important conservation of tin in this field.

Let us next consider the possibilities of substituting some other metal for a part or all of the tin in a copper-tin-lead alloy, or of substituting alloys of an entirely different type.

The first metal that presents itself as a substitute for tin is antimony. Antimony combines readily with copper and with lead, and has the property of adding hardness. Unfortunately, however, the hardening effect of antimony is obtained with the sacrifice of ductility. We have found it possible to make alloys carrying as high as 30 per cent. of lead with 3 per cent. of tin and 2 per cent. of antimony. We have also made alloys of 65 copper, 30 lead, 2 tin, and 3 antimony, and have also replaced the 5 per cent. of tin in this alloy entirely with antimony. Car bearings 4¼ by 8-in. size, made from the same pattern on molding machines and subjected to a breaking stress applied longitudinally at the middle of the back of the bearing and throughout its entire length, broke at the following average loads: with 2 per cent. antimony substitution, 60,000 lb.; with 3 per cent. substitution, 62,000 lb.; with total substitution, 52,000 lb.; as compared with a breaking load of 67,000 lb. for the alloy of copper 65, tin 5, lead 30. The castings produced with each of the three abovementioned alloys are not so satisfactory as those made with the straight-tin alloys, being more or less rough, and showing slight globules of lead on the surface. It has been found that a certain amount of nickel can be used for replacing tin with very satisfactory results. The castings produced when zinc is substituted for a certain amount of tin are decidedly

unsatisfactory. The substitution of aluminum for tin is entirely impractical, and such castings are worthless. This does not, however, exhaust all the possibilities of substituting other metals for tin in the copper-tin-lead alloys, but it is my opinion that the substitution of any other metals, in those alloys, can be made only by sacrificing the quality of the alloy.

The possibility of substituting alloys of an entirely different type presents an attractive field for research. The copper-tin-lead alloy has attained its position as the most desirable bronze bearing alloy, but this does not mean that some other alloy may not be found which may give equally good or better results. In the search for such a substitute alloy it should be borne in mind that a bearing metal should possess the following properties:

(1) It should be sufficiently rigid to support the load or resist the impact, but yet not so brittle that it will easily crack.

(2) It should have as great a yielding or plastic nature as is consistent with its ability to support the load or resist the impact without deformation of the bearing as a whole.

(3) The ideal structure combines a hard matrix to support the load and a softer metal or alloy contained within such matrix, to permit the bearing surface to adjust itself to irregularities of service.

(4) It should be easy to handle in the foundry and machine shop.

(5) It should be capable of being remelted without deterioration.

(6) For use in babbitt-lined bearings, it should be capable of being tinned, so that the babbitt can be applied thereto.

(7) It should have good heat conductivity in order to dissipate the heat generated by friction.

Pennsylvania Railroad Anti-friction and Bell Metals

F. M. WARING,* Altoona, Pa.—The necessity for conserving tin has recently been very forcibly brought to the attention of all consumers, and efforts are now being made to reduce the tin content in certain alloys or to substitute other alloys not containing tin.

The approximate composition of the non-ferrous alloys in general use on the Pennsylvania Railroad are given in the accompanying table.

Phosphor bronze is used principally for rod bushings, main-rod brasses, and crosshead shoes.

Ex. B bronze is used to a small extent for backs of car and coach bearings, but the majority of these are now made of the car-journal bronze, which contains, on the average, about 5 per cent. tin.

* Engineer of Tests, The Pennsylvania Railroad Co.

Composition of Non-ferrous Alloys Used by Pennsylvania Railroad

	Copper	Tin	Lead	Phos.	Antimony	Zinc
Phosphor bronze, Spec. 32-C.....	79.70	10.00	9.50	0.80		
Ex. B bronze, Spec. 141..........	76.75	8.00	15.00	0.25		
Car-journal bronze (*a*)..........	(*b*)	(*c*)	(*d*) (*e*)	.....	......	(*f*)
Special high-lead bronze, Spec. 59.	70.00	5.00	25.00			
Lining metal, Spec. 57...........	.....	.....	87.00	.....	13.00	
Dandelion metal................	.....	10.00	72.00	.....	18.00	
Bell metal......................	83⅓	16⅔				
Babbitt, tin-base................	3.70	88.90	....	.....	7.40	
Babbitt for motor bearings.......	1.00	50.00	38.50	.....	10.50	

(*a*) Sum of Cu, Pb, Sn, and Zn, not less than 99. (*b*) Not less than 71. (*c*) Not less than 4. (*d*) Not less than 13. (*e*) Not more than 20. (*f*) Not more than 3.

Car-journal bronze is used for making car and coach bearing backs at the Altoona brass foundry, by melting down old backs after removing the linings and making the necessary addition of new metal to bring the composition within the limits given in the table. No new tin is added in making this alloy.

Special high-lead bronze is used principally for locomotive driving-box shells, which are not lined.

The lead-base lining for car-journal bearings was formerly made up in our foundry from lining metal melted off from old bearings and brought up to specification requirements by the addition of such new metal as might be necessary. Some tin was unavoidably introduced from the old bearings, but the amount allowed in the metal was limited to 2 per cent. Lately we have been using this old lining metal in the preparation of the lead-base dandelion metal babbitt, thus making use of the contained tin in order to reduce the amount of new tin which it was necessary to add to this metal. The journal-lining metal is then made from lead and antimony without the addition of any tin.

Lead-base dandelion metal babbitt, containing about 10 per cent. tin, is used for lining crosshead shoes and also for lining engine-truck and trailer bearings, as well as for hub liners, in place of phosphor bronze, on freight locomotives. This metal has replaced a large amount of tin and tin-base babbitt formerly used.

Bell metal is used exclusively for making locomotive bells, and during 1917 about 42,800 lb. of castings were made, involving the use of a little over 7000 lb. of tin.

Tin-base babbitt metal (88.9 tin, 3.7 copper, 7.4 antimony) is used for a number of miscellaneous purposes in the shops, but its use has been greatly restricted and every effort is being made to do away with it where possible, and to substitute a lead-base babbitt or a babbitt with 50 per cent. tin.

The amount of solder having the composition 50 lead, 50 tin, used by the Pennsylvania Lines East, during 1917, was approximately 100,000 lb., but there is reason to believe that a large portion of this can be replaced by a 60-lead, 40-tin solder with satisfactory results, and instructions have been issued to this effect.

In regard to the quantity of new tin used, it is not possible to give the amount, except approximately and from calculations based on the 1917 consumption of bearing metals by the Pennsylvania Lines East only, it is estimated that about 770,000 lb. of new tin were required in a total of about 21,380,000 lb. of all kinds of bearing metals turned out by the foundry or purchased in the market.

No change has been made in the specifications for bearing metals for some years, as the metals used have been satisfactory. A large proportion of the bearing metals are made up from old material re-melted and brought to standard composition by some addition of new metal, and every effort is being made to utilize old material to the best advantage and reduce the amount of new metal of all kinds purchased. For a number of years no tin has been used in the lining metal of either passenger or freight car journal-bearings, except such small amounts as come in from re-melting old linings. No change has been made in phosphor bronze used for rod bushings, as we should expect some trouble from bushings pounding out of shape if a phosphor bronze were used which contained less tin or more lead than the present specifications call for. In this, as well as in the case of all other bearing metals, we expect to use our utmost endeavors to economize and to substitute for tin wherever possible.

The Tin-plate Industry

D. M. Buck,* Pittsburg, Pa.—During the first 5 months of 1918, approximately 11,000,000 lb. per month of pig tin were consumed in the United States. Solder, bearing metals, bronzes, etc. used about 5,500,000 lb.; collapsible tubes a little more than 250,000 lb.; tin-foil about 500,000 lb.; and the tin- and terne-plate industry somewhat less than 5,000,000 lb. In an effort to reduce this consumption and thus conserve our tin supplies, several methods of procedure suggest themselves:

1. Salvage. The most careful and systematic collection and re-use

* Metallurgical Engineer, American Sheet and Tin Plate Co.

of tin and tin-bearing materials is economically important, in that we thus secure the maximum benefits from our available supplies.

2. Substitution of other materials for tin. While tin, on account of its low melting point, softness, malleability, non-toxicity, etc., is peculiarly adapted for many uses, nevertheless it may seem desirable, during times of temporary stringency at least, to substitute for tin and for tin-bearing materials some other substances which may answer our purposes, though perhaps not possessing all of the desirable qualities of tin. It is conceivable that research in this connection may develop entirely satisfactory substitutes which may permanently replace tin for certain purposes.

3. Curtailment, for the time being, of certain lines of manufacture, not absolutely essential to the prosecution of the war.

Efforts along all of the above-mentioned lines are being made in practically all tin-consuming industries, and much progress has been made. In considering the details of tin conservation, it is my intention to confine myself to a brief discussion of this subject as related to the tin- and terne-plate industry.

Terne-plate is a mild-steel sheet coated with an alloy of tin and lead (approximately 25 per cent. tin and 75 per cent. lead). Its chief uses, in normal times, are for roofing, gasoline and oil tanks, and for stamping into various forms. Manufacturers of this material have almost entirely discontinued its manufacture, except to supply the urgent needs of the Government for war purposes.

It has been customary to use a small amount of tin with the spelter in the galvanizing pots in the manufacture of galvanized sheets. It has been found that, by a sacrifice of no other quality than appearance, this tin could be omitted, and the practice has been largely discontinued —entirely so in the concern with which the writer is connected.

Tin-plate consists of thinly rolled mild-steel sheets coated with pure tin, and its chief use is in the canned-food industry. The Government has requested that the manufacturers of this product give absolute priority to orders covering material to be used for the manufacture of plate for cans to contain perishable foods. The manufacturer has, of course, complied with this request and the conditions of the markets have been such that almost the entire capacity of the country has been utilized for such material, and for other direct and indirect Government needs.

Several grades of tin-plate are regularly manufactured, differing only in thickness of the tin coating. While, for some few uses, the heavier coated sheets are desirable and necessary, it is a fact that the most lightly coated sheets are entirely suitable for a very large percentage of these requirements. It is in this connection that the consumer can materially aid in the saving of tin during the present stringency, and also prevent

a serious economic waste in normal times, by not specifying a heavier coated plate than his requirements justify.

For years it was believed by certain canners, manufacturers, and dealers in canned goods, that a heavy tin coating was necessary on food containers. This opinion was endorsed by food officials and chemists, and attempts have been made in Congress to regulate the weight of tin coating. Since the literature on the subject gave no definite information, a committee was formed several years ago, consisting of representatives of the American Sheet and Tin Plate Co., American Can Co., and the National Canners' Association. Two representatives of the Bureau of Chemistry, Department of Agriculture, also participated in the work. This committee prepared seven lots of tin plate with the following average coatings, expressed in pounds of tin per base box (112 sheets, 14 by 20 in.).

	Pound		Pound
A	0.9	*E*	1.8
B	1.1	*F*	2.1
C	1.3	*G*	3.0
D	1.5		

Cans were made from these plates in the usual way, and various food products were packed under the supervision of the committee, in regular canning plants. Approximately 60,000 cans, in all, were packed with the following foods:

Apples (3 packs)	Milk (evaporated)
String beans	Peas
Cider	Pumpkin (3 packs)
Clam juice	Tomatoes (3 packs)
Corn (3 packs)	Tuna
Milk (condensed)	Salmon

The cans and contents were inspected and analyzed from time to time, throughout a period of about 18 months after filling the cans. In this work more than 40,000 samples were analyzed chemically. I quote from the general conclusions of this committee as embodied in their report:[2]

The most significant fact established by this entire investigation is that, aside from the external appearance of the cans, none of the difficulties encountered in the twenty experimental packs of twelve representative foods in plain cans was taken care of or eliminated by heavy tin coatings. The luster and the resistance to rusting increase somewhat with increased weights of coating. In other respects, with the exception of some instances in the classes of foods that have a tendency to perforate, the conclusion from this work is that the value of different weights of tin coating on food containers is for all practical purposes the same with average weights of from one to three pounds of tin per base box.

[2] "Relative Value of Different Weights of Tin Coatings on Canned Food Containers." Report of an investigation by a technical committee representing the National Canners Association, the American Sheet and Tin Plate Co., and the American Can Co. Published by National Canners Association, Washington, D. C., 1917.

I bring this investigation to your attention to emphasize the needless waste attendent upon the use of tin plate with an unnecessarily heavy tin coating. With our present knowledge, we are unable commercially to produce coatings as light as the lower weights used in this test. If, however, future research should develop means to this end, the resultant product would meet all practical requirements, and a very considerable saving in pig tin would result.

DISCUSSION

G. H. Clamer.—The National Canners' Association is studying the action of fruit juices, etc., on solders. Of course these tests will take quite a long time, and we hope by that time the war will be over and there will be no need for conserving tin for war purposes. Germany for a great many years has prohibited the use of more than 37 per cent. of lead in alloys used in contact with food products. The eutectic composition is 37 per cent. of lead and 63 per cent. of tin; alloys containing more than that percentage of lead have some free lead.

J. W. Richards,* South Bethlehem, Pa.—A great deal of conservation can result from the packing of dry foods in cartons and in fiber packages instead of using sheet tin. Many of the boxes used for packing things other than food are frequently made of sheet tin because it prints and lithographs well; these could be made of sheet iron coated with copper or some other substitute metal which prints equally well.

The Aluminum Bronze Industry

W. M. Corse,† Mansfield, Ohio.—The conservation of tin, in view of the shipping situation, is one of great importance. Several methods of conservation can be employed:

1. Reduction of the amount of tin in an alloy or compound.
2. Substitution of an entirely different metal or compound for tin.
3. A combination of the first and second methods.

The second method is the one that I wish to discuss.

Metallic aluminum has been known for a long time, and its use in copper alloys was discovered about 1855 by Lord Percy. The high cost of production of metallic aluminum retarded its commercial development, and it was not until the discovery of the electrochemical processes for its production that it came to be known as a common metal.

I have been particularly interested, for the past few years, in working with the alloy known as aluminum bronze, which is usually composed of approximately 90 parts of copper and 10 parts of aluminum, by weight.

---

* Professor of Metallurgy, Lehigh University.

† Manufacturing Engineer, Ohio Brass Co.

This alloy has many properties similar to the copper-tin bronzes, and it has been of interest to find just where the copper-aluminum bronzes could be substituted for the copper-tin bronzes, and in that way conserve the use of metallic tin.

Copper-aluminum bronzes have practically double the tensile strength of tin bronzes, so that a smaller cross-section frequently can be adopted, with the same mechanical result. Their resistance to shock is superior to that of the copper-tin bronzes, and their resistance to wear is, in some cases superior, and in some cases practically equal. Consequently,

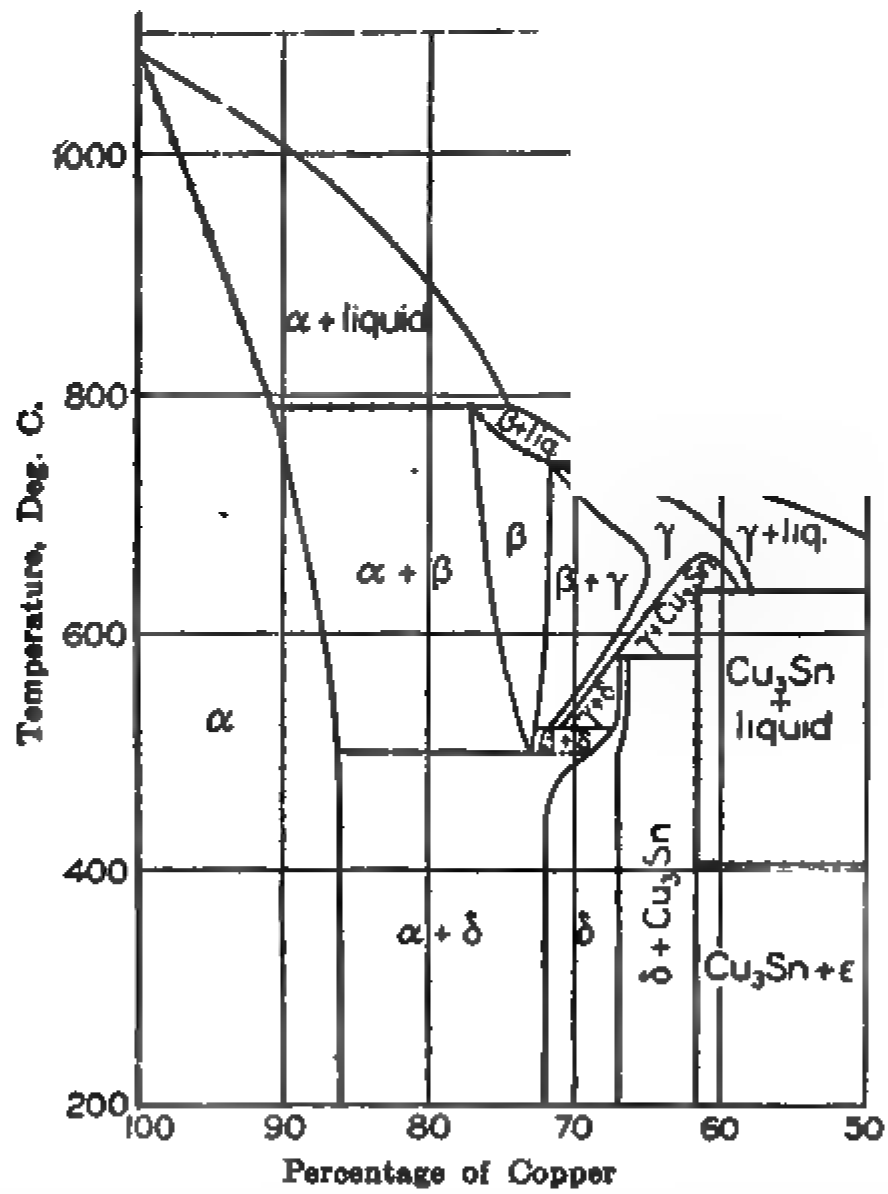


FIG. 1.—THERMAL EQUILIBRIUM OR COOLING DIAGRAM OF COPPER-TIN ALLOYS.

for many mechanical uses, where a hard bronze is desired to replace one containing 10 to 11 per cent. of tin, for example, an aluminum bronze of about the composition mentioned will be found worth investigation. Undoubtedly no two alloys possess exactly the same properties, and when a substitution of one for the other is desirable, it is necessary to work out special methods of handling the substitute in order to get practically the same results.

As is frequently the case in such work, special properties are found to be superior to those of the metal originally used, and other properties

are discovered to be not so good. As a particular instance of the substitution of aluminum bronze for phosphor bronze, I would cite its use in worm gearing. The following tables and curves taken from my paper[3] on this subject before the Society of Automotive Engineers will give an idea of the different properties.

TABLE 1.—*Physical Properties of Phosphor Bronze*

(Composed of 88.7 parts of copper, 11 parts of tin, and 0.3 parts of phosphorus)

Ultimate tensile strength, lb. per sq. in.	35,000–40,000
Yield point, lb. per sq. in.	22,000–25,000
Elongation in 2 in., per cent	6–10
Reduction of area, per cent	7–9
Specific gravity at 20° C	8.5
Brinell hardness number (500 kg. load for 30 sec.)	75–85
Pattern maker's allowance for shrinkage, in. per ft	0.125
Weight per cu. in., lb	0.31
Compression, elastic limit, lb. per sq. in.	16,000
Coefficient of friction	0.0040
Modulus of elasticity	12,000,000 to 14,000,000
Resistance to impact, Fremont notched-bar test (fractured section 7 by 10 mm.), kg.-meters	2 to 4
Endurance of alternating impact, Landgraf-Turner or Arnold test, alternations	150 to 300
Resistance to shear by impact, McAdam machine, ft.-lb.	300 to 450

Aluminum bronze containing 10 per cent. aluminum and 1 per cent. of iron has the physical properties shown in Table 2.

TABLE 2.—*Physical Properties of Aluminum Bronze*

(Containing 10 per cent. of aluminum, and 1 per cent. of iron.)

Ultimate tensile strength, lb. per sq. in.	65,000–80,000
Yield point, lb. per sq. in.	23,000–28,000
Elongation in 2 in., per cent.	20–30
Reduction of area, per cent.	21–29
Specific gravity at 20° C	7.5
Brinell hardness number (500 kg. load for 30 sec.)	92–100
Pattern maker's allowance for shrinkage, in. per ft.	0.22
Weight per cu. in., lb	0.27
Compression, elastic limit, lb. per sq. in.	19,000
Coefficient of friction	0.0025
Modulus of elasticity	15,000,000–18,000,000
Resistance to impact, Fremont notched-bar test (fractured section 7 by 10 mm.) kg.-meters	7 to 10
Endurance of alternating impact, Landgraf-Turner or Arnold test, alternations	3,500 to 5,500
Resistance to shear by impact, McAdam machine, ft.-lb.	750 to 850

[3] W. M. Corse: Worm Gear Bronzes. *Journal*, Society of Automotive Engineers, April, 1918.

It is of interest to note that aluminum bronze would undoubtedly have been substituted for phosphor bronze before this had the manufacturing difficulties with the former been surmounted. Aluminum bronze, when cast in the foundry, presents about as difficult a problem as I have ever seen. It is very sensitive to gas absorption and must be handled extremely carefully to insure good castings. It is similar, from a foundryman's standpoint, to manganese bronze, in that it requires large risers and careful pouring to insure clean castings. Several years' work on this alloy has demonstrated conclusively that it is perfectly

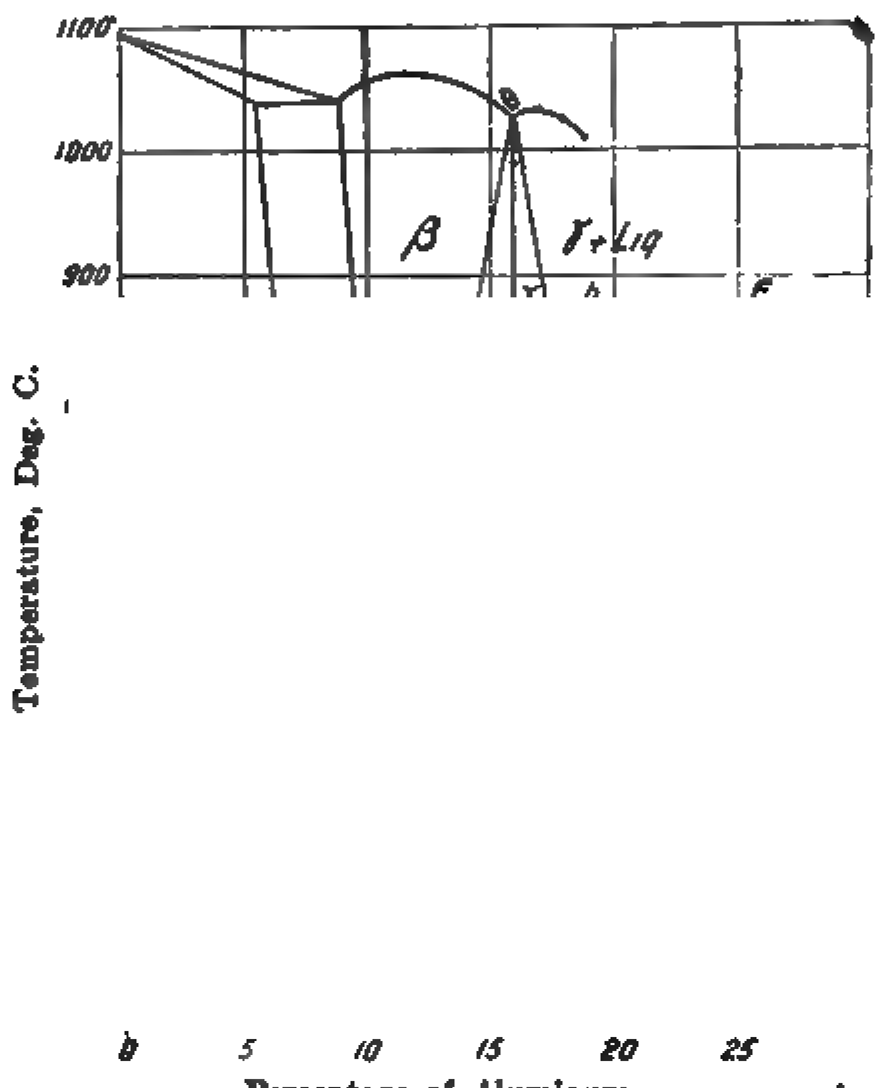


FIG. 2.—THERMAL EQUILIBRIUM OR COOLING DIAGRAM OF COPPER-ALUMINUM ALLOYS.

possible to make as large a percentage of good castings from it as from any other non-ferrous alloy. It seems to me, therefore, that its use should be increased, particularly in view of the shortage of tin at the present time, and undoubtedly new fields will be opened up as its various properties are better known.

One feature that stands out prominently, which was mentioned by the eminent English investigators of this type of alloys, and published by them in the 8th and 9th reports of the Alloys Research Committee of the Institution of Mechanical Engineers of Great Britain, is the fact that cast aluminum bronze possesses properties equal to those of rolled alu-

minum bronze. Nearly all copper-base alloys are improved by rolling processes, but the copper-aluminum alloys seem to possess equally good properties when cast or rolled; this is a remarkable metallurgical fact. Another important property of these copper-aluminum alloys is their resistance to alternating stress. Many tests indicate that their resistance is greater in this respect than that of some steels, and I have seen instances when cast aluminum-bronze bolts have outlived five steel bolts in foundation work subject to severe shocks. I mention these various instances to indicate that work originally started as research for substitution of one material for another frequently develops an article which has properties not possessed by the original metal or alloy.

I have dwelt particularly on the aluminum bronzes because recently I have done more special work on them than on other alloys, but I believe that the use of aluminum itself, in many combinations of metals, is a very important subject for investigation. Undoubtedly, after the war, the cost of aluminum will be reduced from its present price, and considering its low specific gravity it offers a very interesting and important field for research in the non-ferrous business. Naturally, if combinations containing aluminum can be developed in view of a probably increasing supply of metal, the cost will be reduced. This will benefit the industry generally and will immediately conserve tin.

Bronzes, Bearing Metals, and Solders

G. K. Burgess* and R. W. Woodward,† Washington, D. C.—From a metallurgical standpoint, there are several ways in which a reduction of the tin consumed in commercial non-ferrous and white-metal alloys can be effected. First, a reduction of the tin content of the alloy; second, substitution of part or all of the tin content by some other metal; third, a substitution of a different type of alloy, which in some cases also involves a change in mechanical design. The Bureau of Standards has been studying these methods of conservation for tin alloys, particularly in regard to babbitts and bearing metals, bronzes, and solders. Much of the information secured by the Bureau was obtained from answers to questionnaires sent to manufacturers and users of these materials, so that, in general, any of the following suggestions or recommendations can be considered as being practical and as having already been thoroughly tried.

Bearing Metals

There is no question that the tin content of nearly all bearing metals can be reduced to some extent, and in some cases actually eliminated

* Chief, Division of Metallurgy, U. S. Bureau of Standards.
† Assistant Physicist, U. S. Bureau of Standards.

without prejudice to the service rendered. The problem thus is to determine what needs are the most exacting, or when a breakdown would cause the greatest damage, and confine the use of high-tin babbitts to these uses. Thus the main bearings of airplane and military automobile engines, turbine shafts, etc., will probably have to continue to use high-tin babbitt, containing 84 to 91 per cent. tin. A babbitt metal such as S. A. E. specification No. 24, containing 84 tin, 9 antimony and 7 copper, appears to be as satisfactory in service as the genuine babbitt, 89 tin, 7.5 antimony, 3.5 copper, or that specified by the International Aircraft Standards Board, 91 tin, 4.5 antimony, 4.5 copper. But it should be pointed out that the latter two compositions are more fluid in the molten condition than the first named; consequently the lining can be made in a thinner shell with these babbitts, and the total amount of tin consumed may therefore be less than if the S. A. E. No. 24 were used. However, if the design of the bearing is not altered to admit of the thinner shell, the lower-composition babbitt should be used in general.

The following compositions (Table 1) are also recommended for use where a high grade of lining is required and where a genuine babbitt is now often used:

TABLE 1

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Tin	65	62	8	5	10.0	21.3
Antimony	..	..	8	7	12.5	....
Copper	3 to 6	4	4	2	0.5	3.0
Zinc	28 to 30	33	..	76	....	63.3
Aluminum	..	1	..	..	....	....
Lead	..	..	80	10	77.0	12.0

No. 3 and 4 have been found to do the service required of tin-base linings in machine-tool bearings; No. 5 can be used on similar bearings where a greater strain is met. No. 6 is in use in Germany as a "best" babbitt to conserve both tin and copper.

For linings on railroad-truck journals two compositions are in general use, one composed of 85 lead, 10 antimony, 5 tin, and the other of 87 lead, 13 antimony. The latter is restricted by some roads to freight service while the former is used on passenger equipment. Many roads, however, use the 87 lead, 13 antimony, on both classes of service and it seems that its use might be made more universal.

Another type of lining metal which deserves serious consideration is one composed almost entirely of lead, with small additions of alkali or alkali-earth metal. Certain of these have been given service tests at the Bureau of Standards and in many respects were found equal to or superior to genuine babbitt. Table 2 is a summary of the tests on such a

metal, and corresponding tests on genuine babbitt of composition 89 tin, 7.5 antimony, 3.5 copper:

TABLE 2

Load Lb. per Sq. In.	R.p.m.	Total Revolutions	Final Temp. °C.	Final Temp. °F.	Rise in Temp. °C.	Rise in Temp. °F.	Friction, Lb.	Loss in Weight, Gram	Remarks
					Genuine Babbitt				
100	694	12,230	89	192	53	95	22	0.023	
200	706	16,510	102	216	58	104	29	0.021	
300	682	15,150	125	257	100	180	38	0.013	Belt slipping.
400	603	6,600	139	282	94	169	79	0.054	Bearing seized and smoking.
					Ulco Hard Metal				
100	710	13,160	56	133	23	41	13	0.013	
200	715	18,870	69	156	33	59	18	0.021	
300	719	18,830	80	176	42	76	27	0.013	
400	711	17,310	81	178	43	77	23	0.022	
500	723	17,660	79	174	43	77	25	0.014	
600	692	14,960	84	183	45	81	24	0.021	
700	648	24,520	62	144	38	68	24	0.020	
800	365	12,870	53	127	20	36	23	0.010	
900	408	22,300	59	138	22	40	24	0.015	
1000	405	23,200	66	151	36	65	22	0.014	Bearing still good condition.

Standard Grades of Babbitt Metal

At a meeting called by the Conservation Division of the War Industries Board on Apr. 15, 1918, which was attended by manufacturers and users of bearing metals, the Bureau of Standards was requested, after conference with technical representatives of the large manufacturers and users, to determine whether four classes of babbitt metal could be adopted, ranging in tin content as follows:

A, Genuine Babbitt...................... 89 per cent. tin
B.................................. 40 to 50 per cent. tin
C.................................. 4 to 6.5 tin
D.................................. No tin.

The Bureau has gone over the situation with several of the representatives, and the general opinion seems to be that it is impossible to limit some of the classes to a single composition, because of the fact that several compositions of nearly the same tin content are in general use for different purposes. Thus, in the table below, No. A-1 is used in aircraft engines, No. A-3 is used for automobile engines, No. A-4 is found in bearings of electrical machinery. It was thought, however,

that class B can be entirely dispensed with, as these intermediate-tin bearing metals are in no way as satisfactory as either a high-lead or a high-tin babbitt. In all cases where class B could be used, classes C or D will be found to serve the purpose equally well. There are, however, some grades of babbitt containing about 65 per cent. of tin which do not fall into either class A or class B, but are often claimed by the manufacturers to equal the high-tin babbitt in performance. If these claims can be substantiated, this babbitt should be considered as falling into the category of class A and as being a substitute for alloys in that class.

It should not be presumed, because high-tin babbitt of class A is included, that the Bureau recommends the continuance of its use for many bearings in which it is now used. The lowest possible tin alloy should always be used, and the Bureau believes that it might be advisable to allow some central body to issue licenses for the use of babbitt in class A, in order to insure that no A babbitt is being used where others are satisfactory.

Alloy D-2 has been included in class D because this comprises babbitt metals containing no tin. It should be noted that this alloy will be found satisfactory in many installations where class A has hitherto been used, and its inclusion in class D should not give the impression that it is a low-grade babbitt.

The American Society for Testing Materials has drawn up specifications for 12 compositions of babbitt metals (B23–18T) which, however, do not take into consideration the factor of tin conservation, but are formed for use in peace times. The present recommendations are for use in the existing situation, where the saving of all tin possible is of prime importance.

The recommended compositions for the various classes are given in Table 3. These have been selected so as to include existing specifications and usage as far as possible. Much information has been secured from the questionnaire sent out by the Bureau and from replies to the general letter issued by the War Industries Board on May 29, 1918.

TABLE 3.

Class	No.	Tin, Per Cent.	Antimony, Per Cent.	Lead, Per Cent.	Copper, Per Cent.	Iron, Per Cent.(a)	Arsenic, Per Cent.(a)
A	A-1	91	4.5	1(a)	4.5	0.08	0.10
	A-2	89	7.5	1(a)	3.5	0.08	0.10
	A-3	84	9.0	1(a)	7.0	0.08	0.10
	A-4	83	8.5	1(a)	8.5	0.08	0.10
C	C-1	5	10.0	85	0.5(a)	....	0.20
D	D-1	..	13.0	87	0.5(a)	....	0.25
	D-2	(b)	(b)	98(b)	(b)	(b)	(b)

(a) Maximum. (b) Remainder is alkali and alkali-earth metal.

More than traces of impurities other than those listed above will not be allowed, the following variations above or below the specified amount will be permissible for the desired elements:

Percentage of elements specified	Permissible variations from specified value
Not over 5 per cent.	0.50
5 to 10 per cent., incl.	0.75
Over 10 per cent.	1.00

Large quantities of phosphor-bronze of the composition 80 copper, 10 lead, 10 tin, deoxidized with phosphorus, are used in unlined bearings at fairly high speeds and pressures. The following compositions (Table 4) have been suggested as substitutes for this composition, although it is our opinion that trouble will sometimes be experienced with Nos. 8, 9, and 10, because of their high lead, and these have about the same tin content as the others in the list.

TABLE 4.

	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
Copper	81	79	74	64	Remainder	Remainder
Tin	7	5	5	5	8	5.0
Lead	9	15	20	25	15	17.5
Zinc	3	..	..	..	1.5–3	5.0
Antimony	..	..	..	5	...	....
Phosphor-copper	..	1	1	1	...	....

Structural Bronzes

Considering bronzes other than those used for bearing purposes, we find that "Government Bronze" (Navy Specification, 46M6a, Gun Metal), or 88 copper, 10 tin, 2 zinc, is used in large quantities and can be modified to admit of a saving of tin without impairment of the physical properties sought. Experiments by the Bureau of Standards and others have shown that a composition of 88 copper, 8 tin, 4 zinc, is equal or superior to the ordinary Government bronze. Aluminum bronze, of composition 90 aluminum, 10 copper, for example, can also be substituted for many uses of Government bronze; so also can manganese bronze and naval brass. Several aluminum bronzes containing small amounts of iron have also been introduced, which can be either cast or wrought and are now being employed by several former users of Government bronze.

Some manufacturers have raised an objection to the use of aluminum bronze because the scrap accumulating from this alloy, if it should become mixed with other metals, particularly valuable metals, would have a deleterious effect upon them. This is simply a problem in works

management, requiring proper sorting and routing of scrap. We know of several large manufacturers who make aluminum bronze castings in proximity to steam metal castings, who, by taking the proper precautions, have encountered no difficulties.

Table 5 gives some of the properties of the above mentioned alloys:

TABLE 5.

Alloy	Tensile Strength, Lb. per Sq. In.	Elastic Limit, Lb. Per Sq. In.	Elongation in 2 In., Per Cent.	Authority
Government bronze, 88 Cu, 10 Sn, 2 Zn.	38,860	12,250	25.2	Average of 30 tensile specimens poured in 5 different foundries. Tensile tests made at the Bureau of Standards.
88 Cu, 8 Sn, 4 Zn.....	39,220	11,000	30.6	Same as above; 26 specimens only.
Aluminum bronze.....	71,000	25,000	21.0	Corse & Comstock *Trans.* Soc. Autom. Eng. (1916) **11**, Pt. II, 272–73.
Manganese bronze, U. S. N.	70,000	35,000	30.0	Navy Department Specification 46B15.
Naval brass..........	54,000 over 1 in.	25,000	40.0	Navy Department Specification 46B6b.
	60,000 below ½ in.	27,000	35.0	
Aluminum bronze with iron[1] (Sillman bronze)				
Wrought..........	84,400	14,000	11.5	Bureau of Standards.
Cast..............	78,850	11,500	14.5	Bureau of Standards.

[1] Cu, 86.4; Al, 9.7; Fe, 3.9.

At the suggestion of the Imperial Electric Co., Akron, Ohio, the Bureau also made tests on Government bronze in which half of the tin was replaced by an equal amount of nickel. The averages of several tests on these alloys are shown in Table 6.

TABLE 6.

Partial Composition	Ultimate Strength, Lb. per Sq. In.	Yield Point, Lb. per Sq. In.	Elongation in 2 In., Per Cent.	Reduction in Area, Per Cent.	Modulus of Elasticity, Lb. per Sq. In.
Cu 88, Sn 5, Ni 5, Zn 2............	40,680	13,050	31.8	28.0	17,300,000
Cu 89, Sn 4, Ni 4, Zn 3............	39,675	11,500	31.2	31.2	14,900,000

It will be observed that the above values are exceedingly good for this class of material, and that either of the above alloys can be used as a means of conserving tin.

Many small machine-part castings are made of bronze which can just as readily, or even sometimes better, be manufactured of brass, *i.e.*, copper-zinc alloys. Tin is also looked upon in many brass foundries as a cure-all for poor castings, and is often added to the mixture when trouble is encountered. This practice is not only questionable but should not occur in brass foundries; the cause of the poor castings should be determined and the proper remedies applied in a regular manner.

Solders

The composition of a solder will vary with the use for which it is intended. Formerly, every mechanic believed that nothing was as good as "half-and-half," 50 tin, 50 lead. It is very seldom that a 50-50 solder is necessary in the present emergency, and its use should be eliminated. No solder over 45-55 should be used for hand soldering with the iron, and in the majority of cases 40-60 will serve the purpose. Most plumbers use 40-60 for making wiped joints, whereas 37.5- 62.5 is just as satisfactory for all such purposes. Up to 1.5 per cent. of the tin in a wiping solder can be replaced by antimony, although this element is objectionable in solder for other purposes.

In the manufacture of automobile or airplane radiators, very little solder of higher tin content than 40 per cent. need be used, and in many cases 35-65 solder is being used with success. For the canning industry, both in the manufacture and in the sealing of the can, 37.5-62.5 solder can be used with satisfactory results. Articles which are tinned previous to soldering can be tinned in a bath composed of the eutectic of tin and lead—63 tin, 37 lead. This composition will be found to be fluid and will not segregate as will certain other tin-lead baths.

Cadmium as Tin Substitute

Cadmium appears a promising substitute for part of the tin in solders. The Bureau has been developing such a solder and laboratory tests, together with manufacturing experience, so far point to a composition of 80 lead, 10 tin, 10 cadmium as being practical for many of the purposes for which solder is required. This solder has been tried in the manufacture of tin cans, on roofing materials, and for electrical joints, with encouraging results in all cases. Before using it for food containers, however, it will be necessary to ascertain its toxic properties under various conditions. A test has also been made of it in the manufacture of automobile radiators, with most satisfactory results.

The tensile strength of the cadmium solder is about the same as that of 40-60 solder, but the ductility is approximately twice that of the ordinary solders. The point of complete liquation is only slightly higher than that of the ordinary solders, while the range of solidification is considerably greater. Table 7 gives some of the provisional data on these solders, as compared with tin-lead solders; the tensile properties are the average of four determinations made on a Scott testing machine, the rate of separation being about 12 in. per minute.

TABLE 7.—*Physical Properties of Cadmium-lead and Tin-lead Solders*

Composition	Initial Solidification, °C.	Secondary Solidification, °C.	Final Solidification, °C.	Specific Gravity	Equivalent Volume to 1 Volume, 50-50 Solder	Tensile Strength, Lb. per Sq. In.	Elongation in 2 in., Per Cent.
50 Sn, 50 Pb	210*	181*	149*	8.81	1.00	5698	20.3
40 Sn, 60 Pb	238*	181*	149*	9.47	1.07	5820	26.0
37.5 Sn, 62.5 Pb	245*	181*	149*	9.54	1.08	5383	28.8
90 Pb, 10 Cd	267†	....	249†	11.09	1.26	5000	37.5
80 Pb, 10 Cd, 10 Sn	254	183	143	10.35	1.17	5727	52.3
85 Pb, 10 Cd, 5 Sn	257	202	141	10.67	1.21		
75 Pb, 10 Cd, 15 Sn	....	....	....	10.26	1.16	5880	41.7

* Rosenhain and Tucker, *Phil. Trans.*, Royal Society of London (1918) A209, 89.
† A. W. Kapp: Ueber vollstandige Gefrierpunktscurven binarer Metalllegirungen. *Drude's Ann. der Phys.* (1901) 6, 754.

Because of the preponderance of lead in the cadmium solder, its price is very reasonable; with the present market prices of the metals involved, it is thought that the 80-10-10 solder can be sold, at a profit at 35 c. per pound. It is also thought that plenty of cadmium can be produced as soon as the market for it is created, as American sources of cadmium are undoubtedly available which are not at present exploited.[4]

In meetings with manufacturers of materials containing tin, it is always brought out that the Government is the worst offender, and that many Government specifications call for a lavish use of tin, which is sometimes detrimental to the quality of the material manufactured. We believe that many of these specifications are being revised in order to conserve tin, but there is room for further improvement. As a means of reducing the consumption of tin by the Government, we would suggest the advisability of creating a joint committee of technical representatives of the various departments to pass upon or revise all Government specifications containing tin. Such a committee could be in close coöperation with the manufacturers, and would offer a better opportu-

[4] C. E. Siebenthal: Cadmium in 1917. *Mineral Resources of the U. S.*, 1917, Pt. I, 49–53. Also "Sources of Cadmium in the United States," this *Bulletin*.

nity for the manufacturers to criticise the tin content of Government specifications than is now afforded in any of the Departments.

DISCUSSION

G. H. CLAMER.—Dr. Burgess referred to the objection on the part of foundrymen to the use of aluminum bronze as a substitute for tin bronze, because the aluminum so introduced finds its way into the scrap pile and is the cause of a great many bad heats of metal. A foundry in Philadelphia, which keeps a very careful record of all bad heats, found that 90 per cent., at least, of bad heats are due to aluminum contents. The foundry makes principally copper, tin, and lead alloys, also some red-brass valve metal, etc. The presence of a very small amount of aluminum in mixtures of that kind makes them absolutely worthless, unless they go through a refining process to eliminate the aluminum, which of course is expensive. For years, methods of detecting the source of aluminum in mixtures has been sought. The scrap pile might contain anything from bird cages to valves and miscellaneous pieces weighing from a small fraction of an ounce to maybe thousands of pounds; the fact that such a very small amount of aluminum is injurious means that probably one casting in the whole charge of metal, which may be from several hundred pounds to a ton, is sufficient to cause the rejection of that particular heat; the difficulty is increasing every day, for more and more aluminum is being used in brass and bronze mixtures. Ordinarily it takes some years for brass to get back to the scrap pile, so that while probably 10 years ago we had only a comparatively few bad heats from that source, today the number is gradually increasing as the percentage of aluminum-carrying alloys is increasing.

R. T. ROBERTS,* Elizabeth, N. J.—The wrought-metal manufacturers also are having trouble keeping aluminum-bronze scrap from being mixed with their brass scrap. The two alloys used in wrought-metal are 95 copper, 5 aluminum and 92 copper, 8 aluminum, which have practically the same color as the ordinary 2–1 sheet brass. It is absolutely impossible to run those alloys in an ordinary brass mill and not get them confused with the regular brass. Each alloy is greatly superior to phosphor-bronze, either in a hard or a soft condition. An ordinary 5 per cent. aluminum-bronze wire drawn down to 0.025 in. (0.63 mm.) will have a tensile strength of over 150,000 lb. per square inch (11,250 kg. per sq. cm.). The same is true of an aluminum-bronze sheet for spring purposes. The only way the Government can successfully have aluminum-bronze substituted for phosphor-bronze will be to select one mill to handle the whole output and do nothing else; this would make an immense saving of tin in this present crisis.

* Waclark Wire Co.

Babbitts and Solder

G. W. Thompson,* Brooklyn, N. Y.—This subject has two aspects, neither of which can be ignored: these are the economic aspect and the technical aspect. Under ordinary conditions, economic law will take care of the conservation of tin. Under present conditions it seems desirable that economic law should still be permitted to operate as far as is practicable. It is true that this law operates rather slowly, and that under war conditions it cannot be depended upon to give our Government the supply it immediately needs. There should, therefore, be a designation of the essential industries by the Government, and tin should be supplied for those needs, letting the non-essential industries take what is left. At the same time, information ought to be forthcoming as to how tin can be conserved; with tin selling at 80 c. per pound, more or less, it is to the interest of every consumer to get the best information he can as to how he can save tin. Economic law would properly punish those who do not study their own interests in this way. I deprecate, therefore, any centralized socialistic effort toward avoiding penalties through failure to observe and obey economic law. In saying this, however, I am not unmindful that it is desirable for our Government to take such control of the tin situation as may be necessary to the prosecution of the war, practically regardless of the effect of such action upon individual industry, which should studiously seek to adjust itself to the new condition. The Government should promulgate such technical information as it can collect, showing how tin can be conserved, and should urge upon every consumer the exercise of his common sense in self-protection. There is very little danger of any one attempting to hoard or corner tin, in the present state of the market. Most consumers will be glad to live from hand to mouth, covering their sales by purchases, or *vice versa*.

As to the technical aspects: Tin and tin alloys are used to give certain practical and also certain artistic results. The practical factors are those involved in proper adhesion, continuity of surface, protection, the right degree of hardness, proper working qualities, etc. The artistic results are those that appeal purely to the eye or to our cultivated sense of what is desirable. There is no doubt that a great deal of tin could be saved if there were not a demand for certain pleasing effects. How can this saving be brought about? The users of tin bearing alloys are not the only ones involved in this question. The manufacturers of solder and babbitt have for a long time sought to give certain appearances to their fabricated bars and ingots in order to make them more salable. The user of a solder is very apt to judge of its working qualities by the appearance of the bar; the same thing is true with regard to babbitts. Under ordinary conditions, manufacturers are justified in trying to

* National Lead Co.

produce attractive and consequently more salable products. It would seem, however, that if solder and babbitt were cast in closed molds, just as good practical results would be obtained by the user, without his being able to give preference to solders of unnecessarily higher grade on account of their appearance. It would be hopeless for any one manufacturer of solder to undertake a change of this kind, but if all manufacturers of solder agreed upon it, they would be able, in my opinion, to get the users of solder to take, and to approve by their practical tests, metals containing less tin than they have been accustomed to. The same is true with regard to babbitt metals.

An illustration of how, in the use of an alloy, appearance sometimes is deceptive, is to be found in the case of what may be called intermediate grades of babbitt. I am thoroughly convinced that high-tin or high-lead babbitts are better than those containing both lead and tin with relatively high percentages of each. A high-tin babbitt should not contain more than about 10 per cent. of lead, and a high-lead babbitt should not contain more than 10 per cent. of tin, unless the percentage of antimony can be correspondingly increased. The intermediate babbitts, such as those that contain from 30 to 70 per cent. of lead or tin, may give nice appearing castings that flow easily, but they have not the serviceability of the high-lead or high-tin babbitts. Their hardness diminishes very rapidly as the temperature rises, and they have a relatively low softening point due to the eutectic components present.

The Cadmium Supply of the United States*

C. E. SIEBENTHAL,† Washington, D. C.—From being one of the most maligned of metals—a veritable bugaboo—cadmium has almost overnight become respectable, though its slender claim to respectability rests almost wholly on the possibility of its substitution for tin. Preliminary to any campaign for such substitution, particularly for enforced substitution, the possible supply of cadmium should be determined as closely as possible; for that reason the statistical inquiry of which this paper embodies the results was undertaken.

Production

Cadmium is marketed in two forms, as metallic cadmium, in sticks or bars, and as cadmium sulfide, the pigment. The metal has found its greatest field of use in this country as a component of an easily fusible alloy that is used in automatic fire extinguishers. The sulfide is used to some extent in paints but chiefly to give color and luster to glass and porcelain.

The metal was first made in this country by the Grasselli Chemical

* Published by permission of the Director, U. S. Geological Survey.

† Geologist, U. S. Geological Survey.

Co. in 1907. Since 1910, the production has grown rapidly until, in 1916, the output was over 135,000 lb. and in 1917 over 207,000 lb. The output of cadmium sulfide for the same years increased from 22,000 to 50,000 lb. The market for cadmium was a little slow in the first half of 1918, stocks accumulated to some extent, and production was somewhat curtailed. In the first eight months, the output was 118,700 lb. of metallic cadmium and 36,500 lb. of the sulfide. The stocks on hand Aug. 31 were 161,000 lb. of metallic cadmium and 23,500 lb. of the sulfide. Other companies now manufacturing one or both forms of cadmium are the American Smelting & Refining Co., the U. S. Smelting, Refining & Mining Co. (including the lead smelter at Midvale, Utah and the electrolytic zinc plant at Kennett, Cal.); the Krebs Pigment & Chemical Co.; and the Midland Chemical Co. To these will shortly be added the Anaconda Copper Mining Co., the Judge Mining & Smelting Co., and the Consolidated Mining & Smelting Co. (Ltd.), of Trail, B. C., with the possibility of still others. Several plants producing cadmium-bearing residues have sold them to other companies already equipped to recover the metal. This points the way to custom cadmium-reduction plants large enough to handle economically the product of those plants whose output is too small to justify individual reduction plants.

Sources

There are several cadmium minerals, but none of these occur in profitable quantities as ores. The cadmium of commerce is derived from zinc minerals and ores, in almost all of which it occurs in minute quantity, the ratio being about 1 of cadmium to 200 of zinc. Cadmium behaves metallurgically almost the same as zinc and hence constitutes a fraction of 1 per cent. of almost all spelter. The sources of cadmium that have been utilized are zinc ores treated by fractional distillation, lead-furnace bag-house "fumes," and residues from the purification vats of electrolytic zinc plants and lithopone plants.

Fractional Distillation of Zinc Ores.—Prior to the beginning of production in the United States, cadmium was made principally by Germany, where it was derived from zinc ores by the method of fractional distillation, which has never been practised to any extent in the United States. As cadmium has a higher volatility than zinc, the first vapor to distill over, which is ordinarily caught as "blue powder," contains a greater proportion of cadmium than that going over later. This enriched "blue powder" by special treatment has yielded most if not all of Germany's output of cadmium. Aside from the United States, Germany is the only important producer of cadmium, and her annual output in the years just before the war was about 80,000 pounds.

In the early years of the war, spelter containing more than 0.05 per cent. of cadmium was supposed to be unsuitable for cartridge brass.

Most spelter distilled in the United States and elsewhere averages from 0.2 to 0.3 per cent. of cadmium, the cadmium content ranging from a trace to about 0.75 per cent. The distillers of cadmium-free ores and the electrolytic zinc plants were not able to produce all the high-grade spelter needed for munitions. In this exigency several processes were proposed or revived to remove the cadmium from zinc ores. In one process it was proposed to add carbon to the zinc concentrates near the end of their journey through the long roasting hearth and at the same time bring the temperature up to such a point that the cadmium would distill freely, but not high enough to drive off much zinc. The vapor coming off could be collected and further refined to recover the cadmium. Such a process offers a possibility of recovering some part of the 1500 tons of cadmium contained in the zinc sulfide concentrates produced in the Joplin district in 1917. The acceptance of spelter with 0.5 per cent. of cadmium as Army "high grade," however, took away the incentive to remove the cadmium, though this process was for a time put into practice at one smelter.

Lead-furnace Fumes.—All lead ores contain a certain amount of zinc. In but one important lead-producing district in the United States, the disseminated lead district of southeastern Missouri, is the quantity of zinc too small to pay to separate in ore-dressing. When lead ores are smelted, the infinitesimal quantity of cadmium in the charge is separated from the associated zinc, the latter going into the slag and the cadmium going over with the fumes and being caught in the bag house, together with the lead and arsenic which were in the fumes. When these fumes have accumulated in sufficient quantity they are ignited and burnt to a clinker. This is charged back into the blast furnace, and the cadmium returns over the same route, accompanied by the cadmium content of the fresh charge of ore. Thus the cadmium and arsenic are constantly enriched while the lead remains constant. At one lead smelter, which has been in operation 6 years, the bag-house dust carries 8 per cent. of cadmium. The percentage of cadmium in the bag-house fumes at different smelters ranges from less than 0.1 to 10 or 15 per cent. The rate of enrichment of course depends on the nature of the ore that is being smelted. When the fumes are sufficiently rich in cadmium and arsenic, the arsenic is removed in the arsenic furnace and the residues, which may contain as high as 30 or 40 per cent. of cadmium, are treated for the recovery of that metal. Not all lead smelters are equipped with bag houses, and some lead ores contain very little cadmium. Nevertheless the bag-house fumes from lead blast furnaces must in time become enriched to the point where cadmium can be recovered from them. Such fumes have been hitherto the main source of the cadmium produced in this country.

Electrolytic Zinc-plant Residues.—In the reduction of zinc ores by

leaching and electrolytic deposition of the zinc, the zinc solution, prior to electrolysis, is cleared of cadmium by precipitation with zinc dust, for the presence of more than 0.05 per cent. of cadmium in spelter prevents it being classed as grade A in the Navy specifications. As between a zinc plant and a lead plant treating the same quantity of concentrates the zinc plant would handle from four to ten times as much cadmium because of the greater amount of zinc involved. It can be seen, therefore, that electrolytic zinc-plant residues will soon be a very important source of cadmium. About one-third of the supply in sight at present will come from the zinc plants. As both the zinc and the cadmium are recovered electrolytically the question of metallurgic supervision is simplified.

Since the early part of 1915, the demand for high-grade spelter has been so great that a considerable quantity of prime western spelter has been refined to the high grade either by redistillation or by electrolysis. In electrolysis the anode muds contain the impurities of the original spelter anode, which consist of cadmium, lead, and iron. Some cadmium has been recovered from such muds.

Lithopone-plant Residues.—In making lithopone the necessary zinc is supplied by dissolving in sulfuric acid zinc ashes and galvanizer's drosses, refuse zinc oxide, or roasted zinc concentrates. The zinc sulfate solution thus obtained must be purified by precipitating out the deleterious ingredients, among which is cadmium. The cadmium residues are concentrated to a usable degree of richness and worked up or sold. The cadmium at lithopone plants is most conveniently recovered in the form of the sulfide.

Brass-shop Fumes.—A competent authority estimates that 3 per cent. of the zinc used in brass manufacture escapes in the form of fumes. One-half of this zinc escapes up the flues in the melting and may be precipitated by Cottrell apparatus or otherwise, but the other half escapes into the air in pouring from the melting pots and is lost. The Bureau of Mines estimated several years ago that 400 lb. of cadmium was lost daily in such fumes at Waterbury, Conn. It is likely that the quantity is less now, relatively at least, because of the prevailing wider use in brass-making of spelter practically free of cadmium.

The fumes are richer in cadmium than the spelter used, because of the higher volatility of cadmium. They average about 0.2 per cent. of lead, 2 per cent. of copper, 30 per cent. of zinc, and from 1 to 1.5 per cent. of cadmium. If such fumes were used in the manufacture of lithopone, the resulting residues would be much richer in cadmium than those obtained when zinc ashes are used.

Resources

A canvass was made of lead smelters, electrolytic zinc reduction and refining plants, lithopone plants, and a few typical brass works, with the

object of ascertaining the yearly recovery of cadmium in fumes and residues, the accumulated stocks of such materials, and the maximum yearly capacity of the cadmium-reduction plants. Completeness cannot be claimed for the results, but fairly detailed replies were received from the larger producers. Little attention has been paid to the cadmium content of fumes and residues, especially at plants where it accumulates in small quantity.

According to the data in hand, cadmium is accumulating at lead smelters at the rate of 350 to 400 tons annually and the stocks of fumes contain over 750 tons of cadmium. At electrolytic zinc plants about 200 tons is accumulating annually and the stocks of residues contain about 400 tons. At lithopone plants probably 50 tons is produced yearly and about 25 tons is contained in stocks. In round numbers, then, 600 tons accumulates annually, and there is on hand approximately 1200 tons in stocks of fumes and residues. Not all the stocks are rich enough for the cadmium to be commercially recovered but perhaps material that carries 1000 tons is suitable for treatment. The average recovery of cadmium is about 75 per cent. We may therefore estimate 750 tons of recoverable cadmium in residues in stock. An increase in the number and capacity of electrolytic zinc plants will correspondingly increase the annual accumulation of cadmium.

Reduction Capacity

The maximum capacity for metallic cadmium reported by producers is 29,000 lb. a month, or about 175 tons a year. This capacity will be increased by the entrance into the producing list of the electrolytic zinc plants mentioned above. If the price of cadmium and the demand for it should justify expansion, the producing capacity could no doubt be brought up with reasonable promptness to 500 tons or more yearly. The price of cadmium will be the deciding factor also in determining what grade of cadmium fumes can be worked at a profit.

Prices

In 1875, cadmium was quoted in the United States at $3.20 a pound. In 1886, the average price for the total output of Germany was 80 cents a pound; but in 1890 and 1892, it fell off to 38 cents. In 1897, because of certain purchases by the Imperial Government, the price rose to $1.23 a pound. In 1907, when the United States began making cadmium, the German average price was 84 cents. The price in the United States went down to 53 cents in 1909, but it has been steadily rising since. In 1916, the average price was $1.56 a pound; and in 1917, it was $1.47.

The cost of material for tin and cadmium solders of various formulas is shown in the following Table 1.

TABLE 1.—*Cost of Material in* 100 *Pounds of Solder, Oct.* 1, 1918

	50 Parts Lead 50 Parts Tin Dollars	60 Parts Lead 40 Parts Tin Dollars	80 Parts Lead 10 Parts Tin 10 Parts Cadmium Dollars	92 Parts Lead 8 Parts Cadmium Dollars
Lead at 8.05 cents..	4.03	4.83	6.44	7.41
Tin at 80 cents.....	40.00	32.00	8.00	
Cadmium at $1.50..	.....	.....	15.00	12.00
Total cost.....	44.03	36.83	29.44	19.41

The solder containing 80 parts lead, 10 parts tin, and 10 parts cadmium can be made as cheaply as the half-and-half solder with cadmium at $3.00 a pound and as cheaply as solder containing 60 parts lead and 40 parts tin with cadmium at $2.25 a pound. The solder containing 92 parts lead and 8 parts cadmium can be made as cheaply as the lead-tin solders with cadmium at $4.00 and $3.25 a pound respectively.

DISCUSSION

M. L. LISSBERGER,* New York, N. Y.—We have heard a good deal about replacing the tin in solder by cadmium, but we have not heard anything about using cadmium in bronzes, brasses, and many other places where cadmium is already found with the zinc. If, however, only 160,000 lb. of cadmium are available and it is desirable to conserve tin, why not substitute cadmium for tin in bronze first? Those who have worked in cadmium think little of it in a solder. Cadmium solder may have its uses in electrical work, when it is made in the form of wire or ribbon, and is melted with a blowpipe; but when used for bath work, cadmium is soon oxidized and the bath becomes unworkable. As soon as an attempt is made to mix cadmium and lead, the cadmium is converted into an oxide. A tin-lead solder is an absolutely permanent mechanical mixture; to use cadmium solder until its permanency is known is dangerous. In addition, the effect of cadmium solder on food is not known; but it is known that solder containing 80 per cent. lead should not be used in any food container where there is any danger of the lead getting into the food.

There are means of conserving tin without danger. Bearing manufacturers could use all the cadmium that will be available for the next 3 or 4 years if a method for thus using it could be found, and thus save the tin now used in bearings for purposes where a dependable substitute has not yet been found. The use of phosphor-tin frequently permits the use of less tin in a mixture, because in many cases tin is used merely to smooth the mixture. But one of the chief places to

* President, Marks Lissberger & Son, Inc.

conserve tin is in the plant. Care should be taken to prevent its going into oxides, drosses, and other waste and not to use scrap that contains tin in mixtures that do not require tin. Scrap containing tin should be employed only in mixtures in which tin must be used.

CHARLES W. HILL,* East Pittsburgh, Pa.—The use of lead-cadmium solders is complicated by the ease with which cadmium oxidizes. The addition of tin or zinc to lead-cadmium mixtures appears to reduce this tendency toward oxidation, so that these solders may be readily used in iron soldering and if precautions against overheating are taken they may be used in pot soldering.

Zinc is only slightly soluble in lead-cadmium mixtures. Increasing percentages of cadmium increase the tendency to oxidation and raise the cost of the solder without increasing its strength. Most of our experiments have been made with a solder composed of lead 90.8 per cent., cadmium 7.8 per cent., and zinc 1.4 per cent. We have experienced no difficulty in preparing these solders using the ordinary precautions of solder mixing. They are stronger than the lead-cadmium-tin solders especially at temperatures above 25° C. At 100° C., they seem to be from 50 to 100 per cent. stronger than half-and-half solder and about 30 to 50 per cent. stronger than pure tin. The tests were made by pulling apart two copper cylinders that had been soldered end to end. This strength at high temperatures is of value in soldering apparatus that will become heated from one cause or another, such as articles which are to be japanned or are heated by steam. In this respect the lead-cadmium-zinc solders are much superior to lead-cadmium-tin solders.

The lead-cadmium-tin solders cannot be fluxed well without the use of a metallic chloride flux such as zinc chloride. They give good results on certain metals with organic fluxes, such as rosin or glycerine, but the soldered joint is stronger when zinc-chloride fluxes are used. We have soldered tin cans with zinc-cadmium-lead solders without the use of a flux. The matter of flux is of extreme importance in many cases, because of the corrosive action of excess flux left on the soldered article. This is true with copper.

It is quite probable that any danger from the use of these solders for tin cans used for foods would arise from the lead content and not the cadmium, which, contrary to the opinion expressed, is quite a stable element, except at high temperatures. It would obviously be dangerous to employ such solders in contact with foodstuffs without sufficient experimentation. The lead content of solders can be lowered and it is quite possible that some of the higher cadmium solders will not be injurious to health and will not be attacked by the contents of food cans.

In conclusion it may be said that lead-cadmium zinc solders are

* Research Laboratory, Westinghouse Elec. & Mfg. Co.

entirely suitable for certain uses and even possess advantages over present solders at high temperatures, but they are certainly not suitable for all uses. However, it is conceivable that their use in many places will effect a material conservation of tin. It will probably be wiser to use cadmium in solders where good results have been obtained than in brass where this element will be a source of possible trouble.

F. F. COLCORD,* New York, N. Y.—The cadmium-lead solder has a higher conductivity than the lead-tin alloy, which ought to make it advantageous in the manufacture of electrical machinery. In the case of solder for tin-can work, one of the high officials of the American Can Co. said that he fully intended to give it a good trial, and I do not believe they are going to reach hasty conclusions and run the risk of poisoning the public.

Solder, Its Use and Abuse

MILTON L. LISSBERGER,† New York, N. Y.—Solder is a mechanical mixture of tin and lead, a fact which is susceptible of very simple demonstration. A bar of solder of a grade even as low as 30 per cent. tin and 70 per cent. lead, passed through a buffing machine, will show a surface practically identical with that of a bar of second-quality or reclaimed tin. The buffings, on chemical analysis, will prove to be almost pure lead.

According to the best practice, solder is made in the following manner. Virgin pig lead is first melted, and when it is thoroughly liquefied, virgin pig tin is added, together with a small amount of flux; the latter is for the purpose of bringing to the surface the so-called "liver," consisting of impurities that may have remained in either the lead or the tin as a result of incomplete refining. The combined material, when completely liquid, is thoroughly stirred for some hours, and is then cast into small pigs. Just before casting, and continuously during this operation, the molten metal yields dross, consisting largely of the oxides of lead and tin; this should be carefully skimmed off.

After the pigs have cooled, they are taken to a smaller kettle, remelted, and cast into the desired shape for use; or if wires, ribbons, etc., are to be made, the solder is cast into slugs suitable for extrusion and rolling. During this second operation, the skimming of dross should be even more carefully done than at first.

Hand mixing has proved to be the only reliable method for the production of the best quality of solder, irrespective of its percentages of lead and tin. The best quality of solder is not necessarily that which contains the highest percentage of tin, but rather is that composition which performs best on the required piece of work. In order to produce

* U. S. Metals Refining Co.

† President, Marks Lissberger & Son, Inc.

a thorough mechanical mixture, it is necessary to stir for a long period; experience has shown that to perform this operation satisfactorily takes from 5 to 6 hr., irrespective of the quantity of material being mixed, and also irrespective of the proportion of tin in the mixture, whether 60 per cent., or as low as 30 per cent.

Throughout the casting process, what occurs is that the lead solidifies in skeleton crystals until the remaining liquid has the eutectic composition, when it freezes at a constant temperature as a mechanical mixture of tin and lead containing some tin in solid solution. It is remarkable how many shapes these skeletons take. The seeming explanation of this variation is the presence of other metals than tin and lead, in very small proportion, or even traces.

An analysis made, in 1901, of borings taken from a section of a pig of solder at the points indicated in the accompanying diagram[1] showed the tin content to be as follows: No. 1, 59.06 per cent.; No. 2, 52.99 per cent.; No. 3, 38.43 per cent.; No. 4, 39.07 per cent.; No. 5, 45.62 per cent.; No. 6, 39.33 per cent.; No. 7, 38.82 per cent. Table 1 gives the breaking stress of twenty-five grades of wire solder of No. 9 Birmingham gage; tin wire of this gage breaks when subjected to a stress of 120 lb. and lead wire, when subjected to a stress of 49 lb. Table 2 gives the bursting pressures per square at different temperatures for twenty-four grades of solder; in each case the pressure is dead, not expansive.

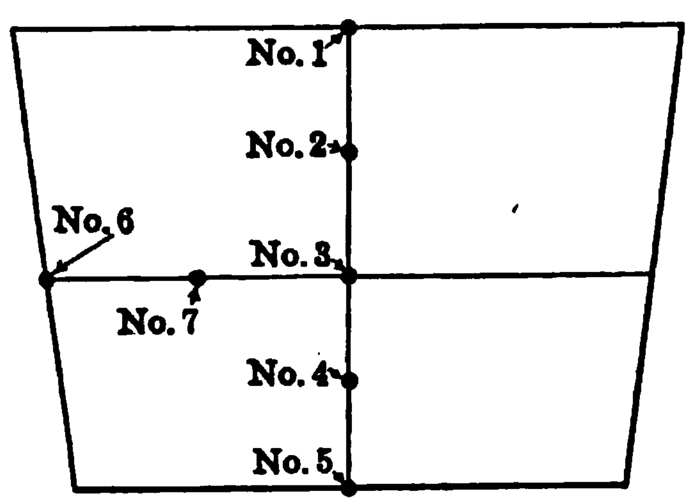


DIAGRAM SHOWING POSITION IN PIG OF BORINGS.

In arriving at these figures, it was impossible to use an expansive test because, after a number of experiments, it was observed the figures differed materially. It was then determined to use dead pressure, and this was found accurate with an atmospheric temperature of 56° F.; but when the tests were subjected to heat at 212° F. it was discovered that the length of time to which the test was subjected in this degree of heat made an important difference in the amount of pressure required to produce the burst. When subjected to 240° F. the difference was found still greater, and in both cases the longer the test was subjected to heat the less pressure was required to produce the fracture. The figures giving the bursting points at 212° and 240° must, therefore, be regarded as only approximately correct.

With the idea of conserving tin, solders should be separated into two classes:

[1] For this diagram and the tables appended we are indebted to Dr. G. W. Thompson of the National Lead Co.

TABLE 1.—*Breaking Stress of Wire Solder of No. 9 Birmingham Gage*[2]

Tin, Per Cent.	Lead, Per Cent.	Breaking Stress, Pounds	Tin, Per Cent.	Lead, Per Cent.	Breaking Stress, Pounds
25	75	65	48	52	93
28	72	68	50	50	95
30	70	69	52	48	97
33.3	66.6	73	54	46	98.5
35	65	74	56	44	101
36.5	64.5	78	58	42	103
37	63	79	60	40	105
38	62	80	62	38	106.5
38.5	61.5	78	64	36	108
40	60	84	67	33	109.5
42	58	85	70	30	112
44	56	87	75	25	115
46	54	91			

TABLE 2.—*Bursting Pressure per Square Inch of Solder at Different Temperatures*

Tin, Per Cent.	Lead, Per Cent	At 56° F., Pounds	At 212° F., Pounds	At 240° F., Pounds
25	75	362	146	74
28	72	384	158	77
30	70	417	170	84
32	68	436	179	88
33.3	66.6	443	181	89
35	65	460	188	93
37	63	476	196	97
38	62	482	199	99
40	60	493	202	100
42	58	497	208	103
45	55	505	212	105
46	54	508	213	106
48	52	515	215	107
50	50	522	220	109
52	48	527	223	111
54	46	527	223	111
56	44	528	223	111
58	42	533	227	113
60	40	533	227	113
62	38	535	227	113
64	36	539	227	114
66	34	541	227	114
70	30	550	230	115
75	25	561	235	118

[2] Experiments made by F. W. Schultz and recorded in his book on Solder published in 1908.

(1) That which is used strictly for soldering, that is, joining and holding together two pieces of metal.

(2) That which is used primarily for the filling of an interlocked joint, so as to prevent the escape of the contents of a container. It is these filling metals that offer the greatest opportunity for the conservation of tin. It is only necessary that the metal shall flow into the seam, and solidify into an impenetrable mass.

The greatest abuse of solder occurs in the use of high-tin mixtures for filling metals. A mixture of 25 per cent. tin and 75 per cent. lead, worked at the right temperature and with proper fluxing, is high enough in tin for any filling purpose, as has been demonstrated in the practice of the oil canners, notably the Standard Oil Company.

The filling operation is usually conducted by machinery, but the users have frequently not realized that the baths are considerably richer in tin at the top, through which layer the container is being dragged, than the solder that is put into the baths. When the 40:60 solder, most commonly used on automatic can-making machinery, has not worked entirely satisfactorily, it has often been found that the addition of 1 or 2 in. to the depth of the bath has made the solder work very much better. Hence, one of the best means of conserving tin in can-making solder is to deepen all baths, whether on line machinery or for hand dipping, thus permitting the use of a lower-grade solder. Owing to the increasing adoption of the so-called "sanitary can" in the food-canning industry and of the interlocked seam for oil and other containers, it is safe to estimate that over 75 per cent. of the entire consumption of solder is used as filling; hence, the possible saving of tin in this direction becomes highly important.

The fact that solder dross contains a higher percentage of tin than the original solder has usually been explained on the assumption that tin oxidizes more rapidly than lead. The probable explanation is that in solder baths the lead is gradually working toward the bottom and the tin to the top, where it is exposed to the oxygen of the air; thus the oxide of solder is richer in tin than the original solder.

The overheating of solder is not only detrimental to the work, but also causes some, though not a very great, waste of tin through the excessive production of oxide. While this oxidation may be a source of considerable expense to the package manufacturer, it is not actually a very serious loss of tin because the reclaiming of these drosses, or oxides, has been so perfected that very little of the original metallic contents is lost. In these days, however, when every ounce of tin should be conserved, both to insure a sufficient supply for the most essential work, and to save the useless transportation of a material which comes such long distances by boat, overheating should be avoided, and all baths should be covered with a protecting material such as sal ammoniac, oil, charcoal, or ash.

In this connection, it should be emphasized that every particle of solder oxide should be preserved, and sent to the reclaimer. A teaspoonful of solder dross contains enough solder to make a 5-gal. can or 100 No. 1 cans. In many plants, even those of some of our largest consumers of solder, this dross is not collected and saved with sufficient care. It is seldom that a thorough cleaning and gathering together of the oxides takes place more than once a week.

Fire will purify these reclaimed materials, when properly refined, and in purity they will compare favorably with the virgin materials. However, too little attention has been paid to the proper refining of these scrap metals. Usually they have simply been put into a kettle, melted down, and then brought up or down to the required composition. This is not sufficient. Reclaimed metals are never equal to virgin metals, no matter how much refining they undergo; nevertheless, for certain classes of work they are economical and efficient. The repeated use of metal affects its physical permanency; yet the margin of safety in the use of solder is so large, and the length of time that solder is required to remain on the container is so comparatively short, that any lack of permanency can usually be safely disregarded.

After many years of experience, we have developed the following method of manufacture. The lead is first melted at a temperature which does not cause too rapid fusion. After the dross has had a chance to rise to the surface, it is carefully skimmed off before the required amount of tin is added, and slowly reduced to the liquid state. From the moment the tin is added, the solder is stirred by hand for 3 to 4 hr. A scavenger is then added and thoroughly worked for another 3 to 4 hr.; the resulting dross is again skimmed, and the solder is cast into pigs of approximately 80 lb. each. These pigs are then remelted in smaller kettles at a temperature which just causes free fluidity, and the solder is then cast into the desired shapes. During the entire operation of final casting, the caster stirs every time he takes a ladleful from the pot.

This work could be done much more rapidly at higher temperatures, and much more economically by the use of mechanical mixers, but the resulting solder would not be so thoroughly mixed, nor would it be so fluid. Mechanical mixing has a tendency to drive the oxide and dross back into the metals, thus diminishing the holding power of the solder. The scavenger must be chosen with great care, and the amount must be very accurately gaged; otherwise the scavenger becomes a constituent of the finished product, and, instead of being beneficial, is a detriment. We have found that in the grades of solder containing 46 per cent. and less of tin, the addition of ½ to ¾ per cent. of the best grades of antimony increases the fluidity and holding strength of the solder for working tin plate.

Next to its use for containers, the largest consumption of solder

has been on gasolene motor radiators. The hand work on these radiators requires merely a free-flowing clean solder, but on the dipping work, where most of the solder is used, the greatest abuse has been practised. As these radiators are composed of copper, low brass, or ordinary brass, no antimony whatever should be added to the solder used for this purpose. Also the affinity of tin and lead for zinc and copper will draw both of these metals from the radiators into the baths, and as both copper and zinc make solder sluggish, it does not take long (unless proper methods are employed for cleansing the baths) for the solder to become deteriorated.

These baths can be thoroughly cleaned by a mixture of rosin and sulfur, but as this operation produces very disagreeable black smoke throughout the plant, some method should be devised for disposing of it. When sulfur is used for removing zinc and copper, a sufficiently high temperature should be employed to insure the complete combustion of the sulfur. The baths should then be allowed to settle for at least half an hour after such heating, and the top carefully skimmed to remove any sulfides present. It is important to note that the presence of any non-metallic substance is injurious to solder, whether it has been added as a scavenger or is liberated from the original metals.

The question is frequently asked, what is the strongest solder that can be made? Numerous experiments have been made, but the results are confusing. Tests of tensile strength, based upon wires and cast bars, indicate that the higher the tin, up to 75 per cent. tin, 25 per cent. lead, the greater the breaking strength; in the case of two pieces of tin plate soldered together, the maximum strength is given by a solder containing around 42 per cent. tin. Other tests were made on square 5-gal. cans, completely filled with water and then capped; when dropped from a height of about 100 ft., the cans soldered with 46 per cent. tin, 54 per cent. lead, in no case broke at the seams, although the tin plate was ruptured. This was the only mixture that gave this result. Cans soldered with 47 per cent. or more of tin, 53 per cent. or less of lead, and with 45 per cent. or less of tin, 55 per cent. or more of lead, occasionally ruptured at the seams. These experiments were made most carefully and were afterward confirmed by subjecting the cans to air pressure.

I am thus inclined to believe that, in round figures, 46 per cent. tin, 54 per cent. lead, is the strongest mixture that can be used for general soldering purposes, particularly if $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of antimony be added to the mixture. The Bureau of Standards, with the approval of the War Industries Board, suggests that the highest grade of solder permitted should be 45 per cent. tin, 55 per cent. lead. For mechanical soldering, 40 per cent. should be the highest tin ratio, and for most bath work it has been demonstrated that tin from 35 per cent. to 38 per cent., according to the nature of the work, will give ample satisfaction, provided the solder is made properly.

Air Blasts in the Kolar Gold Field, India

Discussion of the paper of E. S. Moore, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, p. 687.

E. S. Moore (author's reply to discussion*).—I have read with much interest Dr. W. F. Smeeth's criticism[1] of my article on the air blasts in the Kolar Gold Field, India. However, before answering the questions he asked, I should like to suggest that possibly the phrase "difference of opinion" might be substituted for the word "misapprehension" when applied to my statement that the matrix of the conglomerate resembles a hornblende schist. This conglomerate is certainly regarded as a metamorphosed sediment. Dr. Evans, who has had wide experience with metamorphic rocks, has regarded this as a clastic rather than an autoclastic rock and mentions it as a probable glacial deposit[2] and similar to the Lower Huronian conglomerate of North America. I was greatly impressed by the similarity between this rock and the bands of Huronian conglomerate in the United States and Canada where metamorphism has rendered the matrix of the rock schistose. It was scarcely intended that the word basal, as used in my text, should be extended to the Kolar field, although possibly it may be equally applicable there. The word is so frequently used on this continent for the Lower Huronian conglomerate, which in many places is the basal formation of the predominantly sedimentary Proterozoic group, overlying the more largely igneous Archeozoic rocks, that it was inadvertently used without special stratigraphic significance for the Kolar area. In reply to Dr. Smeeth's question as to how the conglomerate indicates a syncline, it would seem that if there is present in a closely folded area a band of sediment that is younger than the surrounding rocks, it must be in a syncline in those rocks.

As to an apparent contradiction in the statement on page 693 regarding the compressive stress, it does not seem that such contradiction exists; I think every one will take the same meaning as Dr. Smeeth has taken, which is exactly what was intended.

As to the difference between the minor explosions, or rock bursts, and the larger disturbances, or so-called quakes, shocks, or earth tremors, I

* Received Nov. 4, 1918.

[1] *Bulletin* No. 142 (October, 1918), 1542.

[2] J. W. Evans: *Proc.* Geologists Assn. (1910), **21**, 448.

feel like reiterating the opinion that there is no real sharp distinction between them in many cases, because the same agent that produces the former may aid in producing the latter and in causing them to be of greater intensity. The results of the larger disturbances are very much greater than those of the smaller, but the same strain, inherent in the rocks, causes the larger explosions to occur more frequently and at shallower depths than those at which they would occur if this unusual strain were not present. However, the fact is not lost sight of that heavy shocks have occurred in deep mines in South Africa[3] and in other regions where the superincumbent weight of the rocks alone causes violent ruptures in pillars and other supporting bodies of rock left in mine workings. The physical character of the rock will, of course, have great influence on the intensity of the blast.

As to the cause of the strain in the rocks of the Kolar region, it must still be regarded as due to movements which cause compression in the earth's crust. This seems to be well illustrated by the bursting of rocks, observed by some engineers in the quarries of this country, as well as by the other cases cited in my article.

I notice a small error was made in recording my notes, as a result of which the circular shaft was mentioned as being on the Mysore, instead of on the Champion Reef property (p. 689).

In concluding, I wish to thank Dr. Smeeth for his discussion of the paper and the very valuable data which he has submitted in describing in detail the effects of notable shocks and the methods employed to prevent them.

Method of Fixing Prices of Bituminous Coal Adopted by the United States Fuel Administration

Discussion of the paper of CYRUS GARNSEY, JR., R. V. NORRIS, and J. H. ALLPORT, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* 141, September, 1918, p. 1411.

EUGENE MCAULIFFE,* St. Louis, Mo.—The method employed by the Engineer's Committee in arriving at a proper selling price for coal and coke represents hard painstaking effort based on a thoroughly scientific foundation; and the United States Fuel Administration can well point with pride to the work of this committee. The results so obtained placed

[3] Since the writing of this article, R. N. Kotzé, Government Mining Engineer of the Union of South Africa, has very kindly sent the writer a copy of the Report of the Witwatersrand Earth Tremors Committee, which concluded that the shocks in the mines of that region were entirely the result of mining operations and that they were liable to occur after such a depth was reached that the superincumbent weight of the overlying rocks was sufficient to crush the pillars in the mine workings.

* President, Union Colliery Co.

the whole price-fixing issue above and beyond the sweeping criticism which was directed against the so-called Lane-Peabody prices. The meager cost data available, and the brief time allowed for study of costs, presented an insurmountable difficulty which the Peabody Committee was unable to overcome; its path was in no sense made easy by the attitude of certain producers who looked on the opportunity as one for the exercise of unbridled license, while consumers who hitherto had enjoyed, except for short seasons, an extremely low fuel cost, became not only hysterical in their actions but extremely pointed in their charges. The fact that the Engineer's Committee was able, within a few weeks, to quiet all criticism, winning the endorsement and commendation of both producer and consumer, indicates work of a character and scope deserving of the highest approval.

In the hurry and fervor incident to transforming a nation with but a limited naval force, and with only the nucleus of an army, into a great militant power, little serious consideration is being given to what might be called the readjustment period that will follow the world's war, and the question of making permanent provision for the intelligent control of the coal industry after the war is over is one that may well merit our attention. The experience of the past three years has demonstrated the vital relation that coal as a commodity bears to our governmental and economic structure, and with a war-inflated wage rate in effect when the pre-war competitive condition returns—perhaps suddenly—the very existence of many properties may be jeopardized by an excessive production cost, largely due to the application of uniform unit wage increases made without regard to the physical and market conditions surrounding certain properties.

The doctrine of the survival of the fittest is not a safe one to depend on, inasmuch as the elimination of the unfit might reduce production to a point that would put the remaining producers, temporarily at least, in a commanding position that would prove unsound and perhaps prejudicial to the industry as a whole. While attempting to guard against extraordinary conditions, such as may follow the war, the theory of individualism which gives every man incentive to put forth his best effort must not be lost sight of; it is not only the right but the duty of the State to apply to business a measure of regulation, sufficient to meet the requirements of the well-being of the country as a whole. The rapid unionization of our industrial population bespeaks a further tendency toward what might be termed "limited Socialism" which can, without doubt, be best administered through the medium of intelligent Government control, the regulatory body acting as an intermediary between the producer and his labor on the one hand, and the consumer on the other.

No greater safeguard could be provided for producer and user than the continuation, after the war, of a Federal Fuel Administration,

endowed with plenary regulatory powers. The coal industry transcends in importance the street railway, water, gas, and electric power facilities, and should forthwith be classed a public utility of prime importance. Such regulation must be made broad enough to comprehend, not only the stability of the industry, including prices, but also the conservation of our coal resources; the safety of mine employees; all questions of social, intellectual and hygienic character which surround the mine workers; a definite and consistent plan for expansion commensurate with, but not in excess of our needs; the development of such additional mechanical devices as will admit of maintaining production in the face of a decreasing immigration of the men of that class who have in recent years entered the mines. The Engineering Committee has proved all these questions as possible of solution.

The Mechanics of Vein Formation

Discussion of paper of Stephen Taber, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, pp. 1189 to 1222.

Blamey Stevens, Nogales, Ariz. (written discussion*).—This subject should be approached boldly from the purely physical standpoint. There are usually many known ways of making chemical deposits of any particular mineral and probably many more ways that are still unknown. With physical effects, however, there are, in general, only one or two, or possibly three, ways that will pass muster before the physicist, when he realizes the geological conditions to be harmonized with the physical ones.

Let us consider the second way that Mr. Taber describes: "It (the mineral matter transported in solution) may enter along a fracture, bedding plane, or similar passage, and, as it is deposited, force the wall rock apart, thus making room for the growing vein," because it is the one Mr. Taber chooses for the great bulk of metalliferous veins. By "forcing the wall rock apart" Mr. Taber indicates that he means that the process of crystallization or solidification of the mineral in the vein forces the walls apart. To prove this, he offers a great variety of geological evidence, which, from the physical standpoint, is entirely superficial. From the geological standpoint the evidence is the best to be had, but it is entirely negative and one single grain of really positive evidence will entirely offset it.

Suppose it be granted that there is a considerable force of crystallization. It is well known among physicists that, other circumstances being equal, the crystal would rather form where it does not have to exert that pressure; or, to be more exact, where it is not necessary for the crystal to

* Received Oct. 30, 1918.

do work on external objects. It follows, therefore, that the available channels which Mr. Taber calls "a fracture, bedding plane, or similar passage" would be first filled as far as the available solution would last. But as these passages filled up, they would be exterminated as solution carriers, for certainly Mr. Taber does not consider that merely capillary passages can carry, laterally, enough solution to make a vein. This, then, is positive physical evidence that metalliferous veins are not formed in that way.

My conviction as to how they are formed is contained in my paper, "The Laws of Igneous Emanation Pressure,"[1] and, at a later date, in a less technical article published in the "Mining Magazine."[2] These were preceded by Mr. Graton's paper mentioned by Mr. Taber. The veins are considered to be opened by the pressure of the emanations. These do not necessarily open up a large space all at once; indeed this would be opposed to the physical explanation, for the pressure of the emanations would be sufficiently relieved by small openings being made to the surface. The fractures are forced open a little at a time as they clog up with the material deposited. The illustrations were chosen in an effort to include as great a variety of deposits as possible and no doubt one or two of the cases are outside of the limits allowable to this class of deposit. The only case the physical aspect of which has been since mentioned is that of the great salt domes of Louisiana and Texas. The cause of deposition in this case was the partial evaporation of upward-flowing brine solutions by their own heat and a continually decreasing pressure. The less soluble salts must have remained in the brine, because the solution could hardly be imagined to carry enough temperature in the beginning to make a complete evaporation to saturated steam at atmospheric pressure. This discussion does not mean that Mr. Taber's well known work on asbestos veins is considered incorrect. But it is plain to see that he tries to draw all other veins as nearly as possible into his own particular category.

Stephen Taber (author's reply to discussion*).—In my paper, the geological evidence was summarized in some detail; the physical evidence was largely omitted as this phase of the problem had been investigated experimentally and discussed in earlier papers.[1] The hypothesis that large quantities of mineral matter may diffuse through small capillary or subcapillary passages is supported by experimental proof of the

---

[1] *Trans.* (1912) **43**, 167.

[2] Intrusive Pressure of Mineralizing Solutions. *Min. Mag.* (November, 1914) **11**, 313.

* Received Nov. 6, 1918.

[1] The Growth of Crystals under External Pressure. *Am. Jour. Sci.*, Ser. 4 (1916) **41**, 532–556; and Pressure Phenomena Accompanying the Growth of Crystals. *Proc. Nat. Acad. Sci.* (1917) **3**, 297–302.

permeability of rocks and also by the enormous size of some replacement deposits. In many such deposits, the ore minerals have idiomorphic surfaces where in contact with the partly replaced minerals, thus proving that the ore minerals may be introduced and deposited without the formation of perceptible openings. In laboratory experiments, I have grown small veins, non-fibrous as well as fibrous; and, if these veins could make room for themselves in a few weeks, I see no physical objection to the hypothesis that the larger metalliferous veins may be formed by similar processes.

The hypothesis of igneous emanation pressure advocated by Mr. Stevens is obviously inapplicable to veinlets of calcite and gypsum in regions of unaltered sedimentary rocks, and yet such veins frequently furnish similar evidence that they could not have been deposited in pre-existing open fissures. Certainly Mr. Stevens does not consider that the calcareous concretions found in shale have been formed through the agency of igneous emanations, and yet in such instances the bedding planes of the shale have been disturbed by the growth of the concretions in exactly the same manner as in the case of some vein-walls. The larger concretions may even contain numerous veinlets that do not extend into the surrounding rock.

The Byproduct Coke Oven and its Products

Discussion of the paper of William Hutton Blauvelt, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 135, March, 1918, p. 597.

W. H. Blauvelt (author's reply to discussion*).—The prevention of smoke from byproduct-oven plants is not as simple as would appear from Mr. Moss's statement. All well designed byproduct-oven plants are equipped with ample exhauster capacity, and the suction on the ovens is controlled by highly sensitive pressure governors that control the pressure within a fraction of a millimeter. Of course, this apparatus can get out of order, causing the batteries to smoke, but this does not often happen.

As stated by Mr. Thompson, the smoke produced is made almost entirely during the time of charging the ovens, when they are cut off from the hydraulic main. The amount of smoke that escapes at this time is extremely small, compared with the amount produced by a beehive-oven plant, but the mechanical difficulties in preventing any escape of smoke at charging time are considerable. Several devices are in operation at a number of plants which collect most of the smoke made during charging and several devices are being worked on for its complete

* Received Nov. 2, 1918.

elimination. These will probably be employed only where the smoke is objectionable on account of the location of the plants, as the value of the byproducts in this smoke is very small.

The Use of Coal in Pulverized Form

Discussion of the paper of H. R. COLLINS, presented at the Colorado and Milwaukee meetings, September and October, 1918, and printed in *Bulletin* No. 136, April, 1918, pp. 955 to 961.

A. V. ADAMSON,* New York, N. Y. (written discussion).—The experience of users of pulverized fuel in metallurgical work, particularly for open-hearth furnaces, has demonstrated that high ash and sulfur in pulverized fuel are a detriment, the sulfur in the coal entering into the finished product; hence, in this class of work it is extremely important, when pulverized coal is to be used, that the coal be selected with care, and only those having low percentages of sulfur be used, in combination with proper means for combustion.

I have found that no general statement can be made as to the cost of pulverized coal, each installation being an individual engineering problem and necessitating a varying capital expenditure; as each installation has its own power cost, the actual cost of pulverizing varies between wide margins.

It has been found that no general rule can be laid down as to either fineness or dryness; for some uses a wide range is permissible in both factors, while some classes of fuel require different treatment from others.

Anthracite, coke breeze, and lignite ash will, under certain conditions, form slag, the melting point of the ash from fuel of this character being practically the same as of that from bituminous coal; furnace temperatures above the melting point of ash must therefore cause the formation of slag. However, it should be noted that furnace temperatures attainable with this class of fuel are not usually so high as those from bituminous coal, which probably explains the statement that the former do not slag. In a well designed furnace, temperatures above 2250° F. (1235° C.) will be obtained with that class of fuel, and slags will be formed.

Too much attention apparently has been centered on high CO_2 contents of stack gases. A high percentage of CO_2 is frequently obtained at the expense of the brickwork, the furnace temperature being increased by diminishing the excess air; a high percentage of CO_2 thus simply means a small proportion of O_2.

I cannot agree that the life of a pulverized-coal furnace is as long as

* Construction engineer, Locomotive Pulverized Fuel Co.

that of other forms of furnaces. If the statement be modified to the effect that the life will be the same as that of other forms of furnaces operating under the same capacity rating, this may be true. My experience is that with most pulverized fuel systems the life of the furnace is less. This expense, however, is more than offset by the advantages of using coal in pulverized form.

In general, the papers on this subject are inclined to lay too much stress on the advantages of pulverized coal, regardless of its manner of burning, and overlook the operating difficulties. A wide range of choice is open as to the equipment for drying and pulverizing, since the development of this machinery has been in progress for many years in the cement industry. Hence, the furnace problem is reduced to proper handling, feeding, and burning.

Ash, slag, and clinker are a real problem; to prevent their formation on tubes, checker-work, and furnace walls, is absolutely essential. Methods of combustion, and furnace design are of vital importance. Scientific analysis of the difference in heat transmission due to radiant fuel and ash in suspension has offered a real opportunity for research. None of these items can be disregarded; yet the beaten highway of cement practice has offered no answer because in long-flame rotary kilns, such as are used in cement work, these questions are of no importance.

For four years the organization with which I am connected has labored with these subjects, and I am frank to say that the ground has not yet been fully covered. Such progress as has been made is due to progressive development based on practical operating experience on locomotives, heating furnaces, and boilers. The facts that have been definitely settled can be summarized as follows:

1. Pulverized coal is not suitable for all purposes, and the character of the fuel available is one of the factors causing the necessity for separately considering each proposed installation.

2. Honeycomb and ash on tubes, and slag on walls and furnace floor, can be controlled.

3. Flame velocity must be reduced to a minimum.

4. No continuous operating efficiency or continuous good results can be obtained with pressure air for combustion, even if only ⅜ oz. pressure is used; and the more nearly a furnace approximates a balanced-draft condition, the better the operating results.

5. The incoming fuel must be mechanically mixed with the air-conveying medium to prevent a pulsating flame and the formation of coke due to lumps of pulverized coal in the feed.

6. In general, the future for the use of coal in pulverized form for steam generating, metallurgical, and chemical work, offers a real opportunity for fuel economy and increased production; it is the one way by which shortage of oil, gas and coal, together with transportation and

labor difficulties can be overcome. Due consideration, however, must be given to the difficulties inherent in and the troubles incident to improper design and installation. In other words, an installation for the economic utilization of fuel in pulverized form is not one which can be purchased over the counter, and special experience or development is essential for each individual installation.

THE CHAIRMAN (J. W. RICHARDS, South Bethlehem, Pa.).—I understand that Mr. Adamson has had experience with powdered coal in locomotives. Are you free to tell us of that?

A. V. ADAMSON.—My experience with locomotives was in Brazil for the Government-owned railroads. Twelve of these locomotives were built and equipped for pulverized fuel in America and shipped to Brazil in the early part of 1917, where they were put into fast-passenger service. The purpose was to burn native Brazilian coal, a means of using which had not been found. On the regular run of 110 miles for the round trip and several hours standby, 6 metric tons of Brazilian coal were consumed. Compared with the same amount on the hand-fired locomotives using American coal at approximately $40 per ton, this effected a saving for each trip of approximately $120. After 6-weeks' service test on one of these locomotives, without opening the firebox except for the dumping of the ash and slag, the flue sheet and tubes were found to be absolutely clean.

These Brazilian coals run very high in sulfur, ranging from 4.5 to 6 per cent. However, no difficulties were experienced due to the sulfur in the coal, neither did it have any deleterious effect on the boiler. These coals run high in moisture and ash, the ash running from 22 to 30 per cent. The moisture was reduced before pulverizing to 3 per cent., and less if possible. A low grade of Brazilian lignite was successfully burned on several trips, although the moisture after pulverizing ran as high as 12 per cent.

CHAIRMAN RICHARDS.—I would like to ask Mr. Collins if the coal must necessarily be dried to 1 per cent. moisture in every case. If it is dried to that extent and is not used at once, coal will absorb 1 or 2 per cent. of moisture from the air. I have been told that coal has been pulverized satisfactorily though containing much more than 1 per cent. moisture.

In regard to the efficiencies attained by pulverized fuel, I believe that the heating arrangement of the furnace itself is a most important factor. Thus, when burning lump coal a grate is necessary, entailing losses through the bars and sides of the grate, and radiation through the roof; whereas, when burning powdered coal, the heat losses from the firebox end of the furnace are largely eliminated.

Mr. Collins states that the costs of different coals prepared and delivered in the furnace are directly comparable on the heat-unit basis.

I wish to urge caution as to the comparing of different fuels on the heat-unit basis, as usually determined. The calorimeter gives a thermal value which includes the heat of condensation of any water produced by the combustion; in practice, this heat of condensation is never utilized and the calorimetric results ought to be corrected to that extent before comparing the practical calorific powers of different fuels. That fuel which has the largest amount of combustible hydrogen and yields the most water, will show a disproportionately high calorific power in the calorimeter, because it will be credited with the heat of condensation of all the water that is formed, which, in practice, always goes up the chimney, as vapor. I should recommend using the practical or metallurgical calorific power of the fuels, and not the calorimetric value, as ordinarily used.

H. H. Stoek, Urbana, Ill.—I should like to ask how much of the ash is lost by passing up the stack, and would this not be troublesome in settled communities?

H. R. Collins.—From a boiler of 250 hp. rating, and running at about 150 per cent. capacity, we obtained about a barrel of ash out of the firebox in 24 hr. Some ash settled in the back chamber underneath the heating surface of the boiler, and the rest passed out of the stack. The fine ash is so light that it floats high in the air, and it lands probably miles away.

Chairman Richards.—One disadvantage of pulverized coal as a matter of national economy is that it offers no possibility of saving any byproducts. Hence the Carbocoal process, followed by pulverization of the semi-carbocoal, from which some of the volatiles have been extracted, would seem to offer great economies.

R. F. Harrington,* Boston, Mass.—I should like to ask about the application of pulverized coal to malleable and gray iron. At one time, considerable difficulty was experienced, due to the deposition of the ash on the metal bath.

H. R. Collins.—As a general rule, the molten metal is drawn first, and the ash, which forms slag on the top of the bath, leaves the furnace last, the same as in open-hearth practice; hence the deposit of ash ought not to be objectionable.

In heat-treatment furnaces, particularly those for malleable iron, there is no trouble at all if the flues are correctly proportioned to the amount of fuel burned, so that the velocity of the spent gases will be sufficient to carry off the ash.

Thos. A. Marsh,† Chicago, Ill.—I would like to ask what success has been attained in the burning of pulverized coke, a fuel containing less than 3 per cent. volatile.

---

* Hunt Spiller Mfg. Co.

† Green Engineering Co.

H. R. COLLINS.—In order to burn pulverized coke, or other fuel low in volatiles, the temperatures must be higher than usual, since carbon ignites at around 900° to 1000° F. Hence we have found it necessary to pass both anthracite and pulverized coke underneath an arch, returning the ignited fuel around the incoming fuel so as to raise its temperature above the ignition point; after which the flame passes into the furnace itself. That is the only way in which we have been able to burn the low-volatile fuels satisfactorily.

CHAIRMAN RICHARDS.—Is it not possible to mix a certain proportion of bituminous coal with anthracite or coke, in order to gain the advantages of both?

H. R. COLLINS.—This can readily be done; about 32 per cent. bituminous coal, ranging above 30 per cent. in volatile matter, can be mixed with anthracite, and the combustion made nearly perfect.

Electrostatic Precipitation

Discussion of the paper of O. H. ESCHHOLZ, presented at the Colorado meeting, September, 1918, and printed in *Bulletin* No. 140, August, 1918, p. 1293.

R. B. RATHBUN,* Salt Lake City, Utah (written discussion†).—While the engineer should carefully weigh the merits of the various types of equipment, he must bear in mind that the object of his plant is the recovery of suspended solids, and a thing is unimportant except as it contributes to this end, other engineering principles being duly considered. The controversy regarding the use of synchronous motor-driven rectifiers by which the power for the treater is taken directly from the mains of the local power system, rather than the motor-generator rectifier giving each treater unit its own isolated electrical system, has led many to think that on the type of rectifier depends the success of the plant. It is in fact a relatively unimportant part of the plant and represents a very small fraction of the investment; the recoveries in dust and fume are practically the same in each case. One large smelting concern has adopted the motor-generator type for all of its plants after years of experience with the synchronous-motor type. Its reasons are practically the same as those set down by Mr. Eschholz for his preference. Given more in detail they are:

1. An independent electric system prevents outside power-line conditions, like voltage fluctuations, from interfering with the operation of the Cottrell plant and eliminates the possibility of the Cottrell plant causing trouble for the power company. The latter, while not very

* Asst. Research Engr., American Smelting & Refining Co.

† Received Oct. 30, 1918.

probable, must be considered, for it is sometimes difficult to convince the transmission engineer that the make and break of the synchronous switch, which is the rectifier, does not introduce destructive voltage transients into his system like the well known phenomena attending high-tension switching. It is not surprising that the power company hesitates to take any chances for the small amount of load acquired.

2. An isolated electric system for each treater prevents the possibility of any disturbance in one treater being communicated to the other treaters through the transformers and rectifiers.

3. By means of the generator-field and the exciter-field regulations, the treater potential may be maintained very close to the critical disruptive value. This is considered essential for good work and can only be equaled when using a synchronous-motor type method by the use of an induction regulator with remote electric control, which is more complicated than a simple rheostat control in the generator field.

4. The motor generator is free from all the drawbacks to which the synchronous motor is subject, such as falling out of step and hunting.

Against these things is urged a slightly smaller first cost and approximately 86 per cent. power efficiency, as compared with about a 76 per cent. efficiency of the motor-generator set. In addition, if the synchronous-motor method is used, the large power system will tend to absorb the surges while the small generator circuit will tend to reflect and magnify any wave distortions that may be present. But if there are no wave irregularities, this function of a large power system is not necessary. Oscillograms taken on a large motor-generator Cottrell plant in Utah showed the treater and transformer circuits to be remarkably free from these surges. In this case, however, the generator wave was a true sine without any irregularities. Oscillograms taken on a large plant at Coram, Cal., where synchronous-motor rectifiers and induction regulators were used, showed that steep wave fronts and surges were present to a marked degree in spite of the absorbing qualities of a large power system. Oscillograms taken on three plants recently constructed, where motor generators were used, showed that under certain conditions of the load voltage transients in the high-tension side of the transformer circuit became troublesome. In these plants the voltage wave was not a true sine, a number of small peaks or harmonics being apparent in the wave. The small peak that occurs just at the point of breaking contact is seen in the oscillogram to be manifest in the wave on the high side of the transformer greatly magnified, due to the steep wave front in the primary wave. From the foregoing it is a fair assumption that if the voltage wave of the generator is a true sine with no steep wave fronts there is no disadvantage due to surges in motor-generator rectifiers. This method, then, should not be condemned on account of a defect in a particular type of generator used. It seems better to correct the defect

in the generator, although this defect has not proved as detrimental as might be supposed, for in every case known to the writer this surge, which makes itself manifest by arcing across a protective spark gap placed across the high-potential terminals of the transformer, decreases so as to be negligible as soon as the gas is in a state permitting good precipitation with either method. There are electrical remedies that often prove beneficial, such as absorbing this oscillating energy by inserting ballast resistance in the primary and secondary circuits or by shunting condensers across the primary circuit. Sometimes the inductive reactance of the circuit may be changed to advantage; and, too, the critical frequency of the system may be changed by changing the rectifier to contact to only one alternation per cycle without any loss in precipitation in the treater.

The disturbance manifest in the high-potential transformer circuit should not be confused with the treater surges that are manifest in sparking across between electrodes, although the latter often set up oscillations that cause surges in the former. The treater surges are said to have their origin in the trailing arc of the rectifier. At any rate, they are especially prevalent if the time of rectifier contact is carried into the neutral part of the wave. A very common cause is the deposition of a dry dust coating on the surface of the passive electrode. The sparks that jump across have all the characteristics of a condenser discharge and it is undoubtedly a case of disrupted dielectric due to being overcharged. It disappears as soon as the dielectric strength of the coating is destroyed.

A matter of considerable importance is that of conditioning the dust particle to assimilate a charge. This is usually done by introducing water into the gas by means of sprays. This does not necessarily increase the conductivity of the treater circuit in the usual sense for, at a number of plants when water is introduced into a dry gas below the boiling point of water, the treater current is greatly reduced, with a corresponding increase in the treater potential and a much improved precipitation. This is especially noticed as the relative humidity of the gas is increased through the range of 30 to 50 per cent. It appears that a conductive coating has been imparted to the dust particle, putting it in a condition to receive a charge, for previous to the admission of water the dust particles pass through the strong electric field of the treater unaffected, although the molecules of the gas are highly ionized. It would be interesting to know if the ionization that is known to accompany water spray enters in and if the agglomeration of the dust particles assists the precipitation.

The discussion of the paper has seemed to establish the fact that the mere presence of the water vapor is necessary without determining a reason. The theory of water being taken up by the particle was set aside on the assumption or statement that no more water was precipi-

tated with the dust after the gas had been humidified than before. The writer does not concur in this assumption, for in his experience the dust precipitated becomes damper with increased relative humidity of the gas, until it becomes a mud above 70 or 80 per cent. relative humidity, in some cases. Some of this water may have been due to the fact that the passive electrode was cooler than the gas, making a supersaturated stratum adjacent to it, but in a number of cases the temperature of this electrode was such that no water could be condensed on it except by surface adsorption. In the very nature of things the dust particle must take up water from the aqueous vapor. By the well-known selecttive adsorption theory, aqueous vapor is known to be taken up by the surface of solids in preference to other gases, such as nitrogen and oxygen, and it is also well known that films of adsorbed moisture persist on the surface of solids at temperatures far above the boiling point. It is only necessary to cite the early work of Bunsen in his effort to remove the last traces of moisture from powdered glass or the exterior of glass tubes.

In regard to the theory of back ionization that has been advanced in the discussion, it is understood, by the writer, that if a dry dust coat covers the passive electrode there is a luminous glow reaching toward the active electrode, which results in reducing the gap in proportion to the length of the glow and this effect disappears as soon as the dielectric strength of the coating is destroyed by moisture. It seems that the glow is due to the fact that the dust particles forming the inner coating have not been able to give up their charge to the electrodes, and cause an electric field in opposition to the field due to the electrodes until they are made conductive and can give up their charge. This is a very promising theory and accounts for the fact that at a certain plant only 16 kv. can be maintained with an electrode spacing of 6 in. when the gas is dry, whereas a potential of 25 kv. or over can be maintained after the gas has been sufficiently humidified. It may also account for the automatic change in ratio between the transformer voltage and the voltage impressed on the treater when the change in the relative humidity of the gas occurs. It seems, however, that the phenomena of the glow can be accounted for sufficiently by the theory of the overcharged gaseous dielectric of a condenser, advanced above.

A common fallacy is the assumption that most of the dust has a tendency to migrate to the passive electrode where the electric field is weakest. Experiments have convinced the writer that more dust is collected on the passive electrode because its greater surface affords a larger place for the particles to lodge and, speaking in terms of unit area, the tendency is really to go to the active electrode where the electric field is strongest, in spite of the electric wind in the opposite direction.

The writer does not share Mr. Eschholz's enthusiasm over the inter-

mittent contact rectifier commonly used. It has a very poor regulation under varying conditions of the gas in the treater and many oscillograms show that the treater voltage often falls to one-half its maximum value between impulses. The rectifier does have the advantage of ruggedness and comparatively low first cost.

For the betterment of the process there is need of securing increased agglomeration of fume, a potential gradient best suited for ionization for an efficient charging of the dust particles, and a decrease in the cost of the treaters.

The Metallography of Tungsten

Discussion of the paper of ZAY JEFFRIES, presented at the Colorado and Milwaukee meetings, September and October, 1918, and printed in *Bulletin* No. 138, June, 1918, p. 1037.

ZAY JEFFRIES (author's reply to discussion*).—Messrs. Merica's and Humfrey's criticisms of some of my conclusions are rendered in the true scientific spirit by means of which differences of opinion are gradually smoothed out and all participants are benefited. It is true that the statement of generalizations on such a complex subject is hazardous, but I shall endeavor to point out the explanations for the discrepancies noted. Owing to the fact that I am now submitting a long paper on the same general subject to the Institute, my present remarks will be brief.

Dr. Merica's Assumptions[1]

I agree with No. 1 and No. 2, with the modification that the *A* (amorphous) metal between grains of annealed metal has substantially the same properties as that at slip planes in deformed metal, but the two have different arrangements with reference to *C* (crystalline) metal and they may be in different conditions as regards internal stress, thickness, and nature of contact with *C* metal.

Assumption 3.—I believe Fig. 1 is wrong. I know of no evidence to substantiate the curves. I believe ϵ_C (elongation of *C* phase) $= 0$ (approximately) at all temperatures and ϵ_A (elongation of *A* phase) has finite values at elevated temperatures only; but these play no important direct role in the ordinary deformation of metals at low temperatures. I believe E_C (elastic limit of *C* phase) $= T_C$ (tensile strength of *C* phase) because as soon as *C* metal begins to deform permanently it would rupture were it not for the *A* metal generated by its breakdown. We know that $E_C = T_C$ in brittle crystals and a crystal cannot be permanently deformed without generation of *A* metal. Therefore Dr. Merica's

* Received Oct. 30, 1918.

[1] *Bulletin* No. 143 (November, 1918).

T_C, in reality, equals $T_{(A+C)}$. Also $E_A = T_A$ for all practical purposes, because when A metal permanently deforms no new stronger phase is formed and hence any unit load which will permanently deform it will eventually break it. If the above is true, Dr. Merica's Fig. 2 is wrong, there being but one set of curves for E_A and E_C which correspond to my Plate 3[2]. The duration of load is very important in A metal. The above reasoning should also be applied to assumptions 4 and 6.

Assumption 8b.—I believe this is not warranted from the evidence at hand and may lead to wrong conclusions.

Assumption 9.—I should like to add a fourth potential path of rupture, namely, at the contact between A and C metals.

Dr. Merica's Conclusions

(*a*) I have concluded, after examining considerable evidence, that at room temperature and lower, in equiaxed tungsten, there is internal stress between A and C metals, probably due to differences in their coefficients of thermal expansion. Call this internal stress IS and Dr. Merica's $T_A < E_C$ becomes T_A, or $E_A - IS < E_C$. My EC_E (equicohesive temperature for elastic limit) is not as Dr. Merica states; it is the temperature at which mixtures of A and C metals have the same resistance to deformation regardless of the initial quantity of A metal present. Obviously, when C metal or a mixture of A and C metals is deformed by Brinell impression, A metal is generated. If the total load is kept constant, the deformation gradually increases the area of contact of the ball and decreases the unit load until a point is reached at which substantially no further deformation takes place; this measures the resistance to deformation of mixtures of A and C metals. The same is true of my hairpin tests; the deformation caused a lessening of the load by shortening the lever arm. In all cases the deformation was caused, to my mind, largely by the movement at the slip planes and slightly, and more particularly at the higher temperatures, by actual deformation of A metal.

(*b*) Dr. Merica's condition for the increase in ductility at lowered temperatures is that the quantity $(T_A - E_C)$ must increase with decrease in temperature. In view of the assumption that $T_A = E_A$, Dr. Merica's condition is identical with mine. It seems to me that increase in ductility of a deformed metal by lowering the temperature has no relation to rupture at grain boundaries; the former holds for the range from highest temperature down to that of maximum ductility and the latter takes place only when the internal stresses between A and C metals exceed a certain amount. Briefly, the cohesion of A and C metals, the quantity

---

[2] *Bulletin* No. 138 (June, 1918), 1072.

and arrangement of the A metal and time of rupture (whether simultaneous or gradual) and rate of loading (especially at high temperatures) will determine the breaking load at a given temperature in the ductile temperature range. With other conditions constant, the breaking load will increase with decrease in temperature proportional to the cohesion of A metal. But with decrease in temperature the elastic limit of the deformed grains, which consist of A and C metals, must increase less than the elastic limit of A metal and more than the elastic limit of C metal. Hence the breaking load increases faster than the elastic limit of deformed grains and ductility must increase with decrease in temperature.

(*c*) Again Dr. Merica's discrepancy is explained by the existence of internal stress between A and C metals. It seems to me that Dr. Merica has unnecessarily complicated this subject by the assumption that the tensile strengths and elastic limits are not equal. With my assumptions, E_A is the average elastic limit of C metal in all directions and E_A is greatly affected by the duration of the load, Dr. Merica's Fig. 2 assumes that $T_A = E_A$ at the melting point. We are all familiar with the brittleness of amorphous substances at very low temperatures, which means that at these temperatures $T_A = E_A$ also. According to Fig. 2, E_A and T_A become farther apart as the temperature decreases and hence could never intersect. Also, Dr. Merica's T_C and E_C curves cannot intersect at low temperatures, yet we know at these temperatures they are equal. The obvious conclusion is that $T_A = E_A$ and $T_C = E_C$.

Reply to Mr. Humfrey

Mr. Humfrey first gives his conception of the quantity and arrangement of the A metal and states that I consider the amorphous cement as occupying a volume in the mass comparable with that of the crystals. My opinions on this subject coincide in the main with Mr. Humfrey's, and I have so stated in reference 34.

My previous remarks on internal stresses between A and C metals at low temperature apply to Mr. Humfrey's suggestions as to the nature of intercrystalline cohesion. He makes one statement, however, which, on its face, seems to be a contradiction to the whole hypothesis; namely, that if the A metal at the grain boundaries gives way for any cause at a load lower than the elastic limit of the C metal, the A metal at the slip planes in the deformed grains should do the same. It is a fact—and this will be discussed fully in my next paper—that the A metal at the slip planes does produce brittleness and, eventually, weakness in the deformed grains, but the effect of the deformation is to lower the temperature at which this brittleness and weakness first appear on cooling. The intercrystalline fracture occurs in recrystallized tungsten at 200° C. and lower. Below room temperature, equiaxed tungsten becomes weaker

with decreasing temperature; also, severely worked tungsten is weaker in liquid air than it is at room temperature, and it is also brittle. The above indicates that either the path of rupture along the amorphous slip planes in deformed grains is greater than at grain boundaries in equiaxed tungsten, or that the *A* metal in deformed grains which has been generated at a comparatively low temperature must be cooled to a lower temperature than that at the grain boundaries to produce a given amount of internal stress between A and C metals.

Mr. Humfrey's belief that future researches will find a method of preparing metallic tungsten which will be free from intercrystalline weakness has been shared by many workers on tungsten. Although recognizing that such a thing may be possible, I am of the opinion that fine-grained equiaxed tungsten will never be produced in such a form that it will be ductile at ordinary temperatures like other metals. Lamp filaments recrystallized in a vacuum and heated at high temperatures for over 1000 hr. are not ductile at ordinary temperature unless a single grain occupies the whole cross-section of the filament for a considerable length, or the grains are greatly elongated, as indicated in Fig. 49. Tungsten rods composed of large grains can be worked and recrystallized in such a manner that each large grain gives birth to many small equiaxed grains which show intercrystalline fracture at room temperature. If we assume that the original large grain should have concentrated its impurities at its own boundary, the small grains produced from it should be cemented together with substantially pure *A* metal. Again, the *A* metal at the slip planes in deformed tungsten grains behaves like the intercrystalline material when a sufficiently low temperature is reached.

I am unable to follow Mr. Humfrey's reasoning with reference to the increase in ductility in a strain hardened metal with decrease in temperature. It is true that an increased tenacity due to release of strains increases ductility at a given temperature, but when the increased tenacity is gained by lowering the temperature, it must be remembered that the resistance to deformation increases also. What makes the tenacity increase faster than the resistance to deformation, Mr. Humfrey's explanation does not say. My contention that in ductile metals the amorphous metal controls the tenacity and that its cohesion increases with decrease in temperature faster than the crystalline metal, satisfies the above conditions, it seems to me, and furthermore, this generality holds for all metals.

Pure Carbon-free Manganese and Manganese-copper

Discussion of the paper of ARTHUR BRAID, presented at the Milwaukee meeting, October, 1918, and printed in *Bulletin* 143, November, 1918, p. 1637.

W. B. PRICE,* Waterbury, Conn. (written discussion†).—It has been our experience, especially in cupro-nickel, that manganese has been very beneficial, not only, as stated by Mr. Braid, in removing sulfur, but also for its property of reducing oxides, thus making the metal more fluid, and enabling it to be poured at a lower temperature; this, in turn, prevents softening of the graphite pots and the absorption of carbon. It also acts very effectively in keeping the carbon in solution in the cupro-nickel, in the combined form. However, in the case of cupro-nickel, to obtain all these benefits it has been found necessary to keep the manganese content as near 0.25 per cent. as possible.

Manganese also is very effective in diminishing the amount of blisters in cupro-nickel. So far as I am aware, both from personal experience and from the experience of others who have been engaged in the manufacture of nickel-silver and cupro-nickel, manganese used either in the form of pure metal or as manganese-copper alloy (30 Mn, 70 Cu) gives better results than any other flux. While this may seem a strong statement, manganese is the natural flux for nickel-silver and cupro-nickel.

Low-temperature Distillation of Illinois and Indiana Coals

Discussion of the paper of G. W. TRAER, presented at the Milwaukee meeting, October, 1918, and printed in *Bulletin* No. 141, September, 1918, p. 1463.

C. M. GARLAND,§ Chicago, Ill. (written discussion‖).—In the development of Mr. Traer's method for the low-temperature coking of Illinois coals, after the principles laid down by Prof. Parr, it was soon demonstrated that, in order to yield a product of uniform volatile content, the coal must be coked in thin layers, and consequently must be handled in comparatively small volumes. This means, in the first place, that great care must be observed in the design of the coking chambers to prevent the loss of the products of distillation, and, in the second place, that labor-saving devices must be utilized to the greatest possible extent in order to reduce the cost of handling.

* Metallurgist with the Scovill Manufacturing Co.

† Received Sept. 30, 1918.

§ Consulting Engineer.

‖ Received Oct. 5, 1918.

There is, however, one advantage in the coking of the material in small volumes, and that is the decrease in the time required for coking. Notwithstanding that the temperatures used are in the neighborhood of 1000° F. (538° C.), it would be safe to predict that the coking time will ultimately be reduced to 3 or 4 hours.

In Mr. Traer's process of carrying out low-temperature distillation, considerable attention has been given to the matter of gas-tight retorts for the distillation; the use of low temperatures has made possible the employment of cast-iron retorts, which can be made practically gas tight, thereby reducing the loss of distillate to a negligible amount.

The reduction of the labor item has been accomplished by the development of a system for the handling of the retorts and containers, involving electrically operated pushers and pullers for the moving of the containers in the retorts, and hydraulically operated doors for the quick opening and closing of the retorts.

The retorts, which may be made of any practical length from 50 to 150 ft. (15 to 45 m.) are operated in pairs, the containers traveling in opposite directions in the two retorts of each pair. A container discharged from one retort is unloaded onto a conveyor, and is then refilled and charged into the next retort of the pair. By this arrangement almost as much coke can be handled per man as in the high-temperature process.

In calling attention to this phase of the process, it should be pointed out that coke is formed in containers having a capacity of approximately 1500 lb. (680 kg.) of coal. The coke is formed in slabs approximately 6 ft. (1.8 m.) long, 1 ft. (0.3 m.) broad, and 4 in. (10 cm.) thick. Since the material is handled in units of 1500 lb., the process does not compare in any way with the briquetting process in which the cost of handling, due largely to the small unit volume, has been all but prohibitive under the conditions existing in this country. Due to the comparatively low cost of handling the material, as developed for this process, and to the high value of the byproducts, the erection of plants having a capacity as low as 125 tons of coal per 24 hr. should be profitable. From plants having a capacity of 300 tons of coal per 24 hr. an excellent return is assured.

Carl Scholz,* Chicago, Ill. (written discussion†).—Mr. Traer's paper on low-temperature distillation of coals is particularly timely, because it deals with two phases of special interest to coal miners and coal consumers.

The action of the Fuel Administration in prohibiting the shipment of Eastern coals to the Western markets presents a problem to the coal producers of the Central West, to prepare their fuel in such manner as to make it compete with the Eastern high-grade bituminous and anthracite

* Consulting Mining Engineer, Chicago, Burlington & Quincy Railroad Co.

† Received Oct. 8, 1918.

coals. This matter has had the serious consideration of many engineers for a number of years, but the low ebb of the coal industry has made investments, even in experimental plants, an impossibility, and it is only in the last 2 or 3 years that some of the Western carriers have been willing to aid in the development of the tests conducted by Mr. Traer.

The writer's interest in the low-temperature distillation of coal dates back to some experiments conducted in the Kanawha District of West Virginia by the process known as "Charite," which is nothing more than the burning of egg coal in long low piles, covered with slack or coke breeze to prevent contact with the atmosphere, thus driving off the higher volatile gases without fusing the coal. Later on, the question of a continuous coking process was investigated, in connection with L. L. Summers, which resulted in the construction of an experimental plant at Haney, Ill.; here some interesting observations were made, the most important of which was the fact that nearly all of the Illinois coals would coke if finely ground and coked under compression.

Since the beginning of the war in 1914, the demand for byproducts has been revived, and the writer recognizes the need for comprehensive and extensive study of this problem because of the increased opportunities to market byproducts at higher prices than were ever dreamed of before, and the need for replacing Eastern coals, which were required for other purposes. The transportation of West Virginia coals to the West by rail has always been an uneconomic procedure, which was emphasized by the car shortage and the need of railway facilities for war purposes. With this in view, the tests conducted by Mr. Traer were very carefully followed.

It is only in recent years that hard coke has been used for domestic purposes, due to the difficulties in obtaining sufficient draft under ordinary conditions. The coke produced by the low-temperature process overcomes all of these difficulties; and, aside from possessing all of the advantages of the best domestic coals, this fuel will store for an indefinite period without any deterioration or slacking. Undoubtedly, when it becomes a commercial commodity, many new uses will be found for it.

Notes on Certain Iron-ore Resources of the World

Discussion of the symposium on this subject, originally conducted by the New York Section, May 23, 1918, presented as a paper at the Milwaukee meeting, October, 1918, and printed in *Bulletin* 141, September, 1918, pp. 1471 to 1496.

The Chairman (J. W. Richards, South Bethlehem, Pa.)—The first point on which I wish to speak is that sufficient attention has not been given to the quality of the ores, in estimating the reserves. I made this same criticism of the work on the iron-ore resources of the world issued by

the XI International Geological Congress. They listed only the ores having present metallurgical value and left out of consideration all others.

However, since metallurgical practice is steadily improving, the worthless ores of today gradually become the commercial ores of tomorrow; hence an estimate to the effect that we shall run out of good iron ore inside of 50 years, if the present rate of consumption is maintained, is of small interest to the metallurgical industry. The world will never run short of ores for producing iron, although it may reach the end of the rich ores such as we now think we cannot get along without.

The second point is that, while the world will never be without iron ore, we cannot get iron out of its ore without fuel; hence the supply of fuel becomes the controlling factor. For this reason, at the XI International Geological Congress, as a companion to the magnificent work on iron-ore resources, I proposed that a similar volume on the coal resources of the world should be compiled. I did not realize at the time that I was unwittingly promoting the designs of the military Junkers. Those countries which have the supply of fuel will control the production of iron. The supply of iron ore is practically unlimited, compared with the supply of fuel by which it must be smelted.

INDUSTRIAL SECTION

This department is devoted to material concerning the products or operations of manufacturers, which, in the estimation of the Editor, is of news value to the mining and metallurgical field, but does not come within the scope of the main editorial section of the Bulletin.

Manufacturers are invited to submit to the Editor items descriptive of new equipment or processes, large or significant installations, and similar material of news character. If found available, items thus furnished will be published in this section without charge, subject to such editorial revision and condensation as may be necessary.

In cases where illustrations are required, cuts of the proper size should accompany the text matter.

I. O. C. TYPE 4-1000 UNIT OXY-HYDROGEN GENERATOR

High-purity gases, because of their unquestionably higher efficiency, should command a higher price than is charged by a commercial gas plant marketing its product to users. If these high-purity gases can be produced at low cost, a maximum profit will ensue. Even where the selling price must compete with that of low-purity gases, a minimum production cost will still make the profit larger. Users of large quantities of gas, whether their demand be steady or intermittent, will find the best economy in the ownership of a proper gas-generating plant, operated under their own control and for their own purposes only. Certain extra expenses are inseparably associated with the use of gases purchased in cylinders. These are: the freight charges on filled and empty cylinders; the cost of handling the cylinders; delays in delivery of cylinders due to freight congestion or other causes, the loss in this respect alone often being sufficient to pay for a generating plant; loss of gas due to leaking valves or breakage of valves in transit or in handling. These extra costs, aggregated through a year and divided by the total volume of gas used, will bring the cost per cubic foot up to a figure which is anything but economical.

With a private gas plant, gas is always available in ample quantities; it is piped direct to the point of application; no cylinders are needed. The I. O. C. type 4-1000 unit oxy-hydrogen generator is an improved electrolytic generator of unit or single cell type which, by its performance, has set a new standard of economy in oxy-hydrogen production. While radically new in mechanical design, it embodies no new principles and is in no sense experimental. It is a development or refinement of earlier I. O. C. unit generators. The International Oxygen Co., of New York City, is the pioneer in the electrolytic generation of oxygen and hydrogen in America. In 1910, it introduced the first commercial electrolytic generator—a unit or cell type made under European patents. Since that time, the history of I. O. C. generators has been one of progressive refinement of type, toward simpler mechanical and electrical design, greater operating economy, and higher purity of gases. Also, the development of I. O. C. generators has brought about a price reduction, until today the new type 4-1000 generator marks a new low level in selling price of high-duty apparatus.

The term "unit" as applied to the type 4-1000 generator, means that each generator is self-contained or complete in itself, capable of generating pure oxygen and pure hydrogen at a rate determined by the amperage of the electric

current supplied. Each unit requires a floor space of 4 in. by 40 in., or about the equivalent of a square foot, and with necessary pipe connections, needs headroom or height of about 6 ft. With this unit as a basis, expansion of plant and increase of capacity become simply a matter of adding units as needed to give the generating capacity sought. No oxy-hydrogen generator made has so large a generating capacity per unit of floor space required. At normal rating of 600 amp., the production per 24 hr. is, conservatively, 105 cu. ft. of oxygen and 210 cu. ft. of hydrogen per square foot of floor area. At 1000 amp., the production per square foot of floor area per 24 hr. is practically 175 cu. ft. of oxygen and 350 cu. ft. of hydrogen.

TRADE CATALOGS

(Under this heading will be listed such catalogs or other advertising literature as may be received during the preceding month. Contributors should address their material to Engineering Societies' Library, 29 West 39th St., New York.)

GENERAL ELECTRIC Co. Schenectady, N. Y.
Bulletin No. 47131. Standard unit alternating-current switchboard panels for general use in small central stations and isolated plants 240 and 480 volts. 1918.

——— No. 47133. Standard unit alternating-current switchboard panels for general use in isolated and small plants 480 and 600 volts. 1918.

——— No. 47135-A. Standard unit alternating-current switchboard panels for general use in isolated and small plants 1150 and 2300 volts. 1918.

——— No. 40017. Small direct-current generators, type ML. August, 1918.

——— No. 47702. Rheostat and compensator operating mechanisms. August, 1918.

GENERAL ELECTRIC Co., IVANHOE REGENT WORKS. Cleveland, Ohio. Catalog No. 276. Ivanhoe metal reflectors and fittings for industrial illumination. 1918.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa.
Catalog No. 550. Cochrane steam and oil separators.

——— No. 710. Cochrane heaters for steam power plants.

Engineering Leaflet No. 18. Testing V-notch meters. Cochrane exhaust steam-heating encyclopedia. 1914.

JEFFREY MFG. Co. Columbus, Ohio.
Catalog No. 175. Jeffrey standard belt conveyors.

RICHARDSON SCALE Co. Passaic, N. J. Descriptive booklet describing Richardson automatic scales for pulverized coal.

STEPHENS-ADAMSON MFG. Co. Aurora, Ill. The Labor Saver. October, 1918.

YARNALL WARING Co. Philadelphia, Pa. Engineering devices for the power plant. Descriptive booklet.

The reserves of manganese ore in Oriente Province, Cuba, are estimated at 700,000 to 800,000 tons, more than 85 per cent. of which are in the district northeast of Santiago. The reserves of marketable chrome ore in Cuba range from 92,500 long tons to 170,000 long tons.

ready to help you on your

1744 Main Street

THE MINING AND METALLURGICAL INDEX

October, 1918

The Engineering Societies Library is prepared to supply the original, or a copy, translation, or abstract of any paper mentioned in the following index, at the following rates:

Translations, per 1000 words: German or French, $3.50; other languages, $4.50 and upward, by arrangement.
Copies of articles, maps, drawings, etc.
Photoprints, 10 by 14 in., per sheet $0.25
Typewritten, per 1000 words 1.00
Bibliographic searching, abstracting, etc., per hour $1.50
Original article, publisher's price, plus postage. Orders for periodicals will be forwarded to the publishers, and bill will be mailed from the Library.

Address communications relating to the Index to Engineering Societies Library, 29 West 39th Street, New York.

In the following Index, volume numbers are given in heavy-faced figures, page numbers in light-faced figures.

MINERAL RESOURCES

(Except Petroleum and Gas. See also Mining Geology and Mining Practice.)

ALASKA, Skagit river, New developments. *Alas. Northw. Min. Jnl.* (Sept., 1918) **12**, 49–51.

ARIZONA, Jerome District of. J. R. Finlay, *Engng. & Min. Jnl.* (Sept. 28, 1918) **106**, 557–62.

CHROME ore in Cuba. *Engng. & Min. Jnl.* (Oct. 5, 1918) **106**, 617.

CHROME ore producers. Editorial. *Min. & Sci. Pr.* (Oct. 26, 1918) **117**, 547.

CHROMITE. J. C. Williams, *Min. & Engng. Rec.* (Aug. 31, 1918) **23**, 160–2.

CHROMITE production urged. *Salt Lake Min. Rev.* (Sept. 30, 1918) **20**, 28–9.

COPPER, lead, gold and silver ores. C. H. Fulton, *Metal Rec.* (Sept., 1918) **4**, 274 et seq.

CORUNDUM in South Africa. *Min. Mag.* (Sept., 1918) **19**, 162–4. From *South Afr. Min. Jnl.*

FRANCE. Metalliferous resources of Bretagne. Les richesses métallifères de la Bretagne. *Métaux Alliages Mach.* (Aug., 1918) 8–9.

FUEL resources, Methods for more efficiently utilising. B. F. Haanel, *Gen. Elect. Rev.* (Oct., 1918) **21**, 689–98. Read before Canad. Soc. Civil Engrs.

GERMAN mineral industry, Raw materials and substitutes. *Min. Jnl.* (Oct. 5, 1918) **123**, 576–7.

GOLD, Economic position of. C. T. Kennan, *Min. & Engng. Rec.* (Aug. 31, 1918) **23**, 156–8.

GOLD, is it an essential or a non-essential? R. H. Tingley, *Salt Lake Min. Rev.* (Oct. 15, 1918) **20**, 27.

GOLD industry, War seriously affects California. *Min. & Oil Bull.* (Oct., 1918) **4**, 490 et seq.

GOLD mining, To the rescue of. *Bull.* 142, Am. Inst. Min. Engrs. (Oct., 1918) 47–50.

GOLD mining as a business. Editorial. *Min. Cong. Jnl.* (Oct., 1918) **4**, 368–9.

GOLD mining conditions, Alleviation of. G. E. Collins, *Engng. & Min. Jnl.* (Sept. 28, 1918) **106**, 581. Letter.

GOLD problem, Review of. H. N. Lawrie, *Min. & Sci. Pr.* (Oct. 26, 1918) **117**, 561–4.

GOLD production, Decline in. *South Afr. Min. Jnl.* (Aug. 24, 1918) **27**, 376.

GOLD production, Encouraging. *Min. & Sci. Pr.* (Oct. 12, 1918) **117**, 475–6.

GOLD propaganda, Bankers endorse. Editorial. *Min. & Sci. Pr.* (Oct. 5, 1918) **117**, 438–9.

GOLD question. Editorial. *Engng. & Min. Jnl.* (Sept. 28, 1918) **106**, 591–2.

GOLD, Situation with regard to. II. *Metal Rec.* (Sept., 1918) **4**, 272–3. Serial.

GREAT Britain, Distribution of silica rocks in. *Quarry* (Oct., 1918) **23**, 101–3. Abs. from Special Reports on Mineral Resources of Great Britain, v. 6.

GYPSUM in South America. *Nature* (Aug. 1, 1918) **101**, 435.

IRON and steel in Luxemburg. *Iron & Steel Tr. Jnl.* (Sept. 14, 1918) 292.

IRON in the Americas. W. A. Reid, *Bull.* Pan. Am. Union (Aug., 1918) **47**, 212–27.

IRON of Lorraine. *Metal Tr.* (Oct., 1918) **9**, 384.

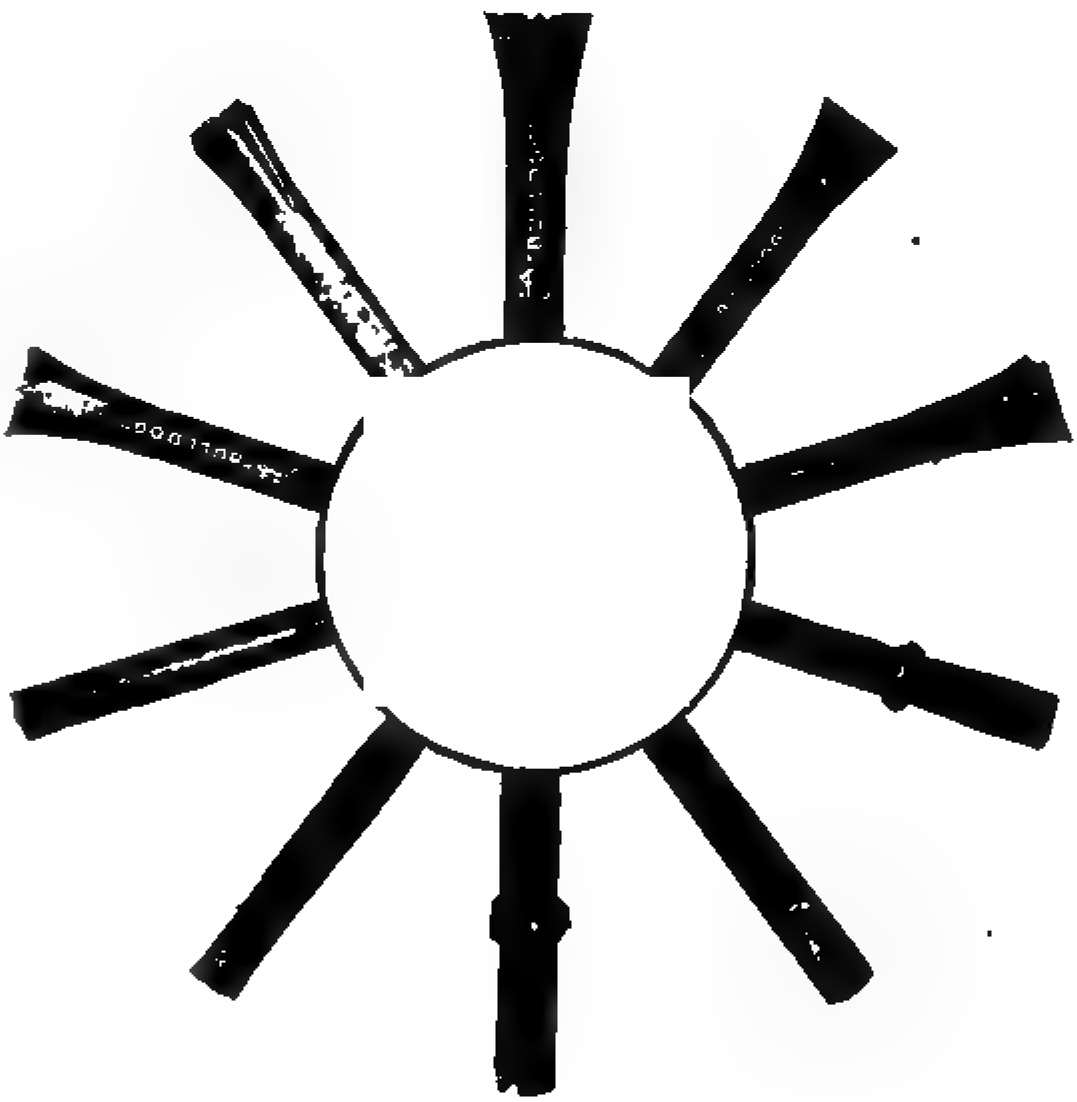
IRON ore formation in Sweden. G. T. Lindroth, Järnmalmsförande vulkanogena (pyroklastiska) amfiboliter inom den mellansvenska leptitformationen. *Teknisk Tidskrift Kemi och Bergs Vetenskap* (Aug., 1918) **48**, 109–20.

"BULLDOG"

Hollow and Solid

MINING AND ROCK DRILL STEEL

THE STANDARD EVERYWHERE



Prompt Deliveries on the Largest Orders.
All Sizes and Sections from Stock.

"BULLDOG" Made-up Drills are Unequalled

SEND FOR PRICE LIST.

INTERNATIONAL HIGH SPEED STEEL CO.

WORKS:
ROCKAWAY, N. J.

OFFICE:
99 NASSAU ST., NEW YORK

IRON ore of Brazil. E. J. Monteiro, *Engng. & Min. Jnl.* (Oct. 26, 1918) **106**, 755. Letter.

IRON ores, Occurrence of in Eastern Holland. W. H. D. De Iongh, Het voorkomen van ijzerertsen in Oost-Nederland. *Ingenieur* (Aug. 24, 1918) **33**, 644–8.

IRON ores of Menez-Bel-Air. M. F. Kerforne, Sur les minerais de fer du Menez-Bel-Air. *Compt. Rend.* Acad. d. Sci. (Aug. 26, 1918) **167**, 341–2.

LATERITE, Metalliferous, in New Caledonia. W. M. Davis, *Proc.* Nat. Acad. Sci. (Sept., 1918) **4**, 275–80.

MAGNESITE in Africa. *Min. Digest* (July, 1918) **19**, 45–7.

MANGANESE and chrome in Newfoundland and Nova Scotia. *Min. Cong. Jnl.* (Oct., 1918) **4**, 404.

MANGANESE deposits in Cuba. *Engng. & Min. Jnl.* (Sept. 28, 1918) **106**, 570.

MANGANESE ore in Georgia. *Science* (Oct. 11, 1918) **48**, 360–2.

MANGANIFEROUS ores of Cayuna Range. *Iron Tr. Rev.* (Oct. 10, 1918) **63**, 837.

MATACHEWAN gold district, Ontario. *Min. Mag.* (Aug., 1918) **19**, 97–9.

METALLIFEROUS ores of iron and steel industry. H. C. H. Carpenter, *Nature* (Sept. 5, 1918) **102**, 7–8. From report on sources and production of iron and other metalliferous ores used in iron and steel industry, by Dept. of Scientific and Industrial Research.

MICA in South Africa. *Min. Mag.* (Aug., 1918) **19**, 99–101. From *South Afr. Jnl. Industries*, Apr., 1918.

MINERAL resources of Empire. *South Afr. Engng.* (Apr., 1918) **29**, 54–6. Serial.

MINERALS and power. F. E. Williams, *Sci. Month.* (Nov., 1918) **7**, 457–64.

MINETTE ore field and world peace. *Steel & Metal Digest* (Oct., 1918) **8**, 603.

NITRATE technology, Chilean. Editorial. *Engng. & Min. Jnl.* (Oct. 12, 1918) **106**, 679–80.

NITRATES, Determination of, in caliche and its products. J. E. Clennell, *Engng. & Min. Jnl.* (Oct. 12, 1918) **106**, 660–3.

NON-METALLIC minerals of the Union. T. G. Trevor, *South Afr. Min. Jnl.* (Aug. 10, 1918) **27**. 329–31.

PLATINUM and allied metals in 1917. J. M. Hill, *Jnl.* Soc. Chem. Ind. (Sept. 16, 1918) **37**, 338R–9. From U. S. Geol. Sur., June, 1918.

PLATINUM prospecting in Southern Spain. *Metal Rec.* (Sept., 1918) **4**, 273.

QUICKSILVER, Production of. *Min. & Sci. Pr.* (Oct. 12, 1918) **117**, 488.

REVENUE act fair to mining industry, Asks for. *Min. Cong. Jnl.* (Oct., 1918) **4**, 379–83.

SOUTHWEST, Notes on certain ore deposits of. W. Tovote, *Bull.* Am. Inst. Min. Engrs. (Oct., 1918) 1593–1612.

SULPHUR, Problem of, in Germany. Problema del azufre en Alemania. *Rev. Minera* (Sept. 16, 1918) **69**, 449–50. From *Technique Moderne.*

SULPHUR, Production of, present shortage and possibilities. *Metal Rec.* (Sept., 1918) **4**, 282–3.

SULPHUR, the king of chemicals. C. MacCulloch, *Am. Industries* (July, 1918) **18**, 36–7.

WAR minerals act approved. *Min. & Oil Bull.* (Oct., 1918) **4**, 471 et seq.

WAR minerals bill. Government's duty to miner. Editorial. *Min. & Sci. Pr.* (Oct. 19, 1918) **117**, 511–2.

WOLFRAM ore and tungsten. *Jnl.* Royal Soc. Arts (Sept. 27, 1918) **66**, 702–3. Report of Departmental Committee on engineering trades after the war.

MINING GEOLOGY AND MINING PRACTICE

(See also Mineral Resources)

ACCIDENTS in mines, Recording. A. H. Fay, *Engng. & Min. Jnl.* (Oct. 19, 1918) **106**, 699–701. Paper presented before National Safety Council.

AIR blasts in Kolar Gold Field, India. *Bull.* Am. Inst. Min. Engrs. (Oct., 1918) 1542–53. Discussion of paper by E. S. Moore in *Bull.* 135, Mar., 1918.

AIR compressors, Modern. D. Penman, *Min. Mag.* (July, 1918) **19**, 12–21.

ALASKA, Notes on mining in. C. C. Semple, *Engng. & Min. Jnl.* (Oct. 26, 1918) **106**, 736–9.

ALASKA, Mining under war conditions. P. C. Stoess, *Engng. & Min. Jnl.* (Oct. 5, 1918) **106**, 611–4.

ANTHRACITE coal stripping. V. T. F. Kennedy, *Coal Age* (Oct. 3, 1918) **14**, 644–7.

BUREAU of Mines war activities. *Salt Lake Min. Rev.* (Oct. 15, 1918) **20**, 29.

CALIFORNIA mining in 1918. *Min. & Sci. Pr.* (Sept. 28, 1918) **117**, 425–6.

CEMENT gun used for repairing pit stacks. *Blast Fur. & Steel Plant* (Oct., 1918) **6**, 399–401.

CEMENTATION at Hatfield Main Colliery. *Min. Mag.* (Sept., 1918) **19**, 155–8.

CEMENTATION process applied to mining. A. H. Krynauw, *Sci. & Art of Min.* (Sept. 21, 1918) **29**, 52–3. Presented before Chem. Met. & Min. Soc. of S. A.

CEMENTATION process, Francois. A. H. Krynauw, *Min. Mag.* (Aug., 1918) **19**, 68–77. Read before Chem. & Min. Soc. of S. A., May, 1918.

CHANCE acetylene safety lamp. W. Maurice, *Iron & Coal Tr. Rev.* (Sept. 20, 1918) **97**, 328; *Coll. Guard.* (Sept. 27, 1918) **116**, 653. Paper read before Inst. Min. Engrs. Sept., 1918.

COAL fields south of Sydney, Recent developments. J. R. M. Robertson, *Coll. Guard.* (Sept. 27, 1918) **116**, 649–51; *Iron & Coal Tr. Rev.* (Sept. 20, 1918) **97**, 321. Abs. paper read before Inst. Min. Engrs., Sept. 13, 1918.

COAL getting, Presidential address, Institution of Mining Engineers. *Iron & Coal Tr. Rev.* (Sept. 20, 1918) **97**, 319.

COAL mines control agreement. Closing and abandonment of mines. *Iron & Coal Tr. Rev.* (Sept. 27, 1918) **97**, 354.

CONVEYOR, Coal trimming, Portable automatic. *Elect. Rev.* [London] (Sept. 20, 1918) **83**, 272–3; *Coll. Guard.* (Sept. 20, 1918) **116**, 601–2; *Iron & Coal Tr. Rev.* (Sept. 20, 1918) **97**, 327.

CONVEYOR, underground coal, Reciprocating. J. F. K. Brown, *Coal Age* (Oct. 10, 1918) **14**, 682–4.

COPPER enterprise, Utah. 1. T. A. Rickard. *Min. & Sci. Pr.* (Oct. 5, 1918) **117**, 445–9. Serial.

DRUM shapes as affecting mine hoist duty cycle and motor rating. F. L. Stone, *Proc.* Am. Inst. Elect. Engrs. (Oct., 1918) **37**, 1203–1221.

DUMPS and dump hoppers. C. L. Miller, *Coal Ind.* (Oct., 1918) **1**, 373–4.

COLONIAL STEEL CO.

RED STAR BRAND

Hollow Drill Steel

RED STAR is a tough, strong, good cutting drill steel, free from interior defects.

The hole is regular and uniform in size and shape and of the same diameter throughout.

STANDARD STOCK SIZES

Round, 1, 1⅛ and 1¼; length, 15 to 18 ft.
Hexagon, ⅞, 1, 1⅛ and 1¼; length, 15 to 18 ft.

COLONIAL STEEL CO.

PITTSBURGH, PA.

Sales Offices: Boston, Mass., New York, N. Y., Chicago, Ill., St. Louis, Mo., Denver, Col., Salt Lake City, Utah.

ORE-DRESSING AND PREPARATION OF COAL

COAL AND COKE

(See also Mineral Resources, Mining Geology and Mining Practice, Ore-dressing and Preparation of Coal)

CRUSHING MACHINERY
AND
MAGNETIC SEPARATORS

Buchanan All-Steel Crusher Type "C"

These Crushers are made in over 20 sizes, from 24 × 36" up to and including 60 × 84". The bearings are all waterjacketed and removable in the larger sizes. Jaw, Cheek Plates and Toggle Bearings of Manganese Steel. Pitman spring balanced and made parting. Underfeed forced lubrication on all bearings. Several sizes made sectional for lowering in mines for underground operations. All steel castings thoroughly annealed. The Buchanan Co. were the pioneers in developing the large ALL-STEEL Sectional Crusher. Our first machine (48") was built over twelve years ago and is still in successful operation. Send for Bulleton No. 10 describing these machines. For medium-size Crushers, send for Bulletin No. 9.

Buchanan Crushing Rolls

Illustration shows our Type "C" Crushing Rolls made in sizes from 18 × 12" to 42 × 16". Type "C" Special from 36 × 18" to 72 × 24" and 72 × 36". This type of Roll is made with Semi-Steel box bed cast in one piece. Bearings are of Phosphor Bronze. The Stationary Roll is provided with fleeting adjustment so that the roll can be moved sideways to prevent grooving. The adjustable roll is provided with our patent swivel pillow blocks which keep the roll bearings in perfect alignment and prevent cramping of the shafts when passing iron or other hard substances through the Rolls. If interested in Rolls, send for Bulletin No. 13.

Buchanan Magnetic Separators

We build eight distinct types c' arators, as follows:

1. Alternating Pole—Drum Type.
2. Belt Type Alternating Pole Pieces.
3. Magnetic Ore Cobbers—Drum ' ype.
4. Magnetic Ore Cobbers—Belt and T um Type.
5. Magnetic Wet Separators for fine
6. Magnetic Wet Separators for coarse ore.
7. Magnetic Head Pulleys.
8. Magnetic Drums with Special Magnets for handling large masses of iron or steel.

Magnetic concentrating plants complete in all details. We have designed and built over a dozen complete plants.

Over thirty years' experience in designing, building and operating Magnetic Separators for practically every known commercial purpose. Send for Bulletin No. 14.

C. G. BUCHANAN CO., Inc.

90 WEST STREET, NEW YORK, N. Y.

PETROLEUM AND GAS

METALLURGY OF IRON AND STEEL

(See also Ore-dressing and Preparation of Coal, Coal and Coke, Metallurgy of Non-ferrous Metals)

WIRE rod mill roll train, Designing passes. W. S. Standiford, *Am. Machinist* (Oct. 3, 1918) **49,** 601–4.

METALLURGY OF NON-FERROUS METALS

(See also Mineral Resources, Ore-dressing and Preparation of Coal, Coal and Coke, and Metallurgy of Iron and Steel)

AEROPLANE construction, Metals used in. W. J. May, *Sci. Am. Sup.* (Oct. 26, 1918) **86,** 262–3.

ALLOY resisting sulfuric acid. F. Milliken, U. S. Pat. 1277989. *Off. Gaz.* (Sept. 3, 1918) **254,** 180.

ALLOYS of copper and zinc. F. Johnson, *Metal Ind.* [London] (Sept. 20, 1918) **13,** 188–90; (Sept. 27, 1918) **13,** 212, Discussion; *Steamship* (Oct., 1918) **30,** 82–3. Read before Inst. of Metals, Sept., 1918.

ALLOYS, Relative corrosion of. R. B. Fehr, *Jnl.* Am. Soc. Mech. Engrs. (Oct., 1918) **40,** 829–33. Abs. of paper to be presented at Dec., 1918 meeting of A. S. M. E.

ALUMINIUM, Annealing. R. J. Anderson, *Engr.* (Sept. 20, 1918) **126,** 251.

ALUMINIUM and aluminium alloys, Contribution to the chemistry of. J. G. A. Rhodin, *Metal Ind.* [London] (Aug. 2, 1918) **13,** 69–72. Read before Faraday Soc. July 23, 1918.

ALUMINIUM and its alloys; Their future after the war. W. Rosenhain, *Metal Ind.* [London] (Sept. 20, 1918) **13,** 181–2. Abs. of lecture read at British Sci. Products Exhibition, King's College, London, Sept., 1918.

ALUMINIUM and its light alloys. II. P. D. Merica, *Metal Rec.* (Sept., 1918) **4,** 278–81; IV. *Chem. & Met. Engng.* (Oct. 1, 1918) **19,** 587–92; V. (Oct. 15, 1918) **19,** 635–40.

ALUMINIUM-bronze alloy, Surprising qualities of new. *Metal Rec.* (Sept., 1918) **4,** 267–70.

ALUMINIUM, Essays on. Essais sur l'aluminium. *Métaux Alliages Mach.* (Aug., 1918) 10–11.

ALUMINIUM industry for Canada. *Min. & Engng. Rec.* (Aug. 31, 1918) **23,** 165–6.

ALUMINIUM founding and the machinery industry. R. De Fleury, *Metal Ind.* [London] (Sept. 6, 1918) **13,** 148–9. Conclusion.

ALUMINUM bronzes, their properties, manufacture and industrial uses. J. Escard, Los bronces de aluminio propiedades, fabricación y utilización industrial. *Rev. Obras Pub.* (Sept. 26, 1918) **66,** 485–92.

ALUMINUM bronze castings. H. Rix and H. Whitaker, Moulage en coquille de bronze d' aluminium. *Métallurgie* (Oct. 2, 1918) **50,** 1455.

ANNEALING cold-rolled aluminium sheet by abbreviated exposures at various temperatures. R. J. Anderson, *Metal Rec.* [London] (Sept. 27, 1918) **13,** 207–11. Read before Inst. of Metals, Sept., 1918.

ANTIMONY, Electric refining. Y. C. Wong, *Chem. & Met. Engng.* (Sept. 28, 1918) **19,** 509.

APPARATUS for the quick testing of metals. Quelques appareils pour l'essai rapide des métaux. *Bull. Tech. Suisse Rom.* (Sept. 7, 1918) **44,** 170–2; (Sept. 21, 1918) **44,** 179–80. Serial.

AUSTRALIAN lead, silver, and zinc. *Engng. & Min. Jnl.* (Oct. 19, 1918) **106,** 704.

BARIUM from strontium, Separating. J. Waddell, *Min. & Sci. Pr.* (Oct. 12, 1918) **117,** 495–6.

BASE metal in South America, Production of. G. H. Stanley, *South Afr. Min. Jnl.* (Aug. 24, 1918) **27,** 377–8. Paper before S. A. Analytical Chemists.

BRASS, Melting in a rocking electric furnace. W. W. Gillett and A. E. Rhoads, *Metal Ind.* [London] (Aug. 30, 1918) **13,** 132–3. Serial.

CASTING metals. F. W. Stokes, British Pat. 117646. *Ill. Off. Jnl.* (Sept. 18, 1918) 2066; British Pat. 117800; British Pat. 117801. *Ill. Off. Jnl.* (Sept. 25, 1918) 2121.

CHARCOAL as a precipitant of gold. *Min. & Sci. Pr.* (Oct. 12, 1918) **117,** 494. Abs. *Bull.* Inst. Min. & Met.

CHROMITE, Determination of chromic oxide in. W. C. Riddell and E. Kittredge, *Min. & Sci. Pr.* (Oct. 26, 1918) **117,** 558–9.

CHROMIUM, its origin and uses. Chrome, ses origines, ses gisements, ses usages. *Métaux Alliages Mach.* (Aug., 1918) 3–8.

CINCHONINE in tungsten assay. *Min. Digest* (July, 1918) **19,** 41–5.

COPPER, Action of reducing gases on hot solid. N. B. Pilling, *Bull.* Am. Inst. Min. Engrs. (Oct., 1918) 1567–80.

COPPER-aluminum alloy, A case of disintegration of a. R. Seligman and P. Williams, *Metal Ind.* [London] (Sept. 20, 1918) **13,** 191–2; (Sept. 27, 1918) **13,** 212–3. Discussion.

COPPER, Cold-working. *Engng.* (Sept. 13, (1918) **106,** 292–3.

COPPER-aluminum alloys rich in copper, Constitution and hardness of. Constitution et dureté des alliages cuivre-aluminium riches en cuivre. *Métallurgie* (Oct. 2, 1918) **50,** 1453–4.

COPPER, Effect of progressive cold work upon the tensile properties of pure. W. E. Alkins, *Engr.* [London] (Sept. 13, 1918) **126,** 216–7; *Metal Ind.* [London] (Sept. 13, 1918) **13,** 164–6: (Sept. 20, 1918) **13,** 192–3; *Page's Engng. Wkly.* (Sept. 27, 1918) **33,** 149–50. Paper read before the Inst. of Metals, Sept., 1918.

COPPER-leaching by salt water and sulphurous gases. C. S. Vadner, *Min. & Sci. Pr.* (Oct. 5, 1918) **117,** 457–8.

COPPER refining. E. W. Rouse. Johns Hopkins University, *J. E. Aldred Lectures on Engineering Practice* (1917–8) 113–39.

CONDUCTORS, Copper and aluminum, used in power transmission. J. A. Montpellier, Cuivre et aluminium conducteurs utilisés pour l'établissement des lignes de transmission d'energie électrique. *Indust. Elect.* (Sept. 10, 1918) **27,** 525–7.

CYANIDATION of silver ore at El Oro, Mexico. F. A. Malins, *Min. & Sci. Pr.* (Sept. 28, 1918) **117,** 419–20.

ELECTRIC arc, Process and apparatus for reducing metals by the. J. G. Webb, Procédé et appareil pour réduire les métaux par l'intermédiaire d'un arc électrique. French Pat. 487493. *Bull. Off. Propriété Indust.* (May 2, 1918) 61.

ELECTRIC furnace in the steel casting industry. W. E. Moore, *Elect. Jnl.* (Sept., 1918) **15,** 331–2.

ELECTRIC furnace problems, Notes on. J. L. McK. Yardley, *Bull.* Am. Inst. Min. Engrs. (Oct., 1918) 1593–8.

ELECTRIC furnaces, Calculation of high tension transformers. R. Jacquot, Étude sur le calcul de transformateurs à forte intensité pour fours électriques. *Rev. Gen. Elec.* (Oct. 12, 1918) **4,** 523–36.

ELECTRIC furnaces. H. Wade, British Pat. 118357. *Ill. Off. Jnl.* (Oct. 16, 1918) 2338.

ELECTRIC furnaces, New. *Elect. Rev.* [London] (Sept. 20, 1918) **83,** 266–8. Serial.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Acids and Ammonia
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Acid, Sulphuric
Illinois Zinc Co., Peru, Ill.

Agitators
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Amalgamators
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corpn., 115 Broadway, New York City.

Asbestos
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Asbestos Materials
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Assay Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway New York City.

Axles, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Balances and Weights
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ball and Tube Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Bearings, Ball
Gwilliam Co., 253 W. 58th St., New York City.

Bearings, Roller
Gwilliam Co., 253 W. 58th St., New York City.

Belting, Conveyor
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Belting, Elevator
Goodrich Rubber Co., B. F., Akron, O.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Belting, Transmission
Goodrich Rubber Co., B. F., Akron, O.

Bins, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Blasting Powder (See Powder, Blasting)

Blasting Supplies
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Blowers
General Electric Co., Schenectady, N. Y.

Blowpipe Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Brake Blocks
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Brick, Fire
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Buckets, Elevator
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Burners, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Burners, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway New York City.

Cableways
Flory Mfg. Co., S., Bangor, Pa.
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Cages, Hoisting
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Cages, Self Dumping and Plain
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Car Lifts, Automatic
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Carbide Lamps
Macleod Co., Bogen St., Cincinnati, Ohio.

Cars, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Castings, Brass
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Castings, Iron
Fuller-Lehigh Co., Fullerton, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Caustic Soda
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Cement Blast Guns (See Guns, Cement)

Cement Machinery
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Cements, Refractory
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Chains
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Chemical Apparatus
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Chemicals
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Chrome Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chrome Ore (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Chute Plates & Launder Liners
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Chutes
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Classifiers
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo
Deister Concentrator Co., Fort Wayne, Ind.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Coal and Ash Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Mining Machines
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coal Mining Plants
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coal Storage and Rehandling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Coatings, Roof
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Collectors, Dust
Macleod Co., Bogen St., Cincinnati, Ohio.

Compass, Maas Patent Drill Hole
Derby, Jr., E. L., Agent, Ishpeming, Mich.

Compressors, Air,
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Concentrators
Colorado Iron Works Co., Denver, Colo.
Deister Concentrator Co., Fort Wayne, Ind.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Condensers, Surface
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Contractors, Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Converters, Copper
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Converters, Electric, Rotary
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Conveyors, Belt
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Conveyors, Cable Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Chain Flight
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Pan or Apron
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Conveyors, Screw
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Core Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Coverings, Pipe and Boiler
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Crucibles
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Crushers, Coal and Coke
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Crushers, Ore
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Mine and Smelter Supply Co., 42 Broadway New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Boradway, New York City.

Crushing Roll Parts
American Manganese Steel Co., McCormick Bldg., Chicago Ill.

 [Please mention this BULLETIN when writing advertisers.]

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Filters
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Fire Clay
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Flotation, Oil
Colorado Iron Works Co., Denver, Colo.

Flue Welding Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Fluorescent Calcium Tungstate
Primos Chemical Co., Primos, Pa.

Fluorspar (Domestic and Foreign)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Forges, Oil and Rivet
Macleod Co., Bogen St., Cincinnati, Ohio.

Forgings, Heavy
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Fuller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Furnaces, Assay
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Electric
General Electric Co., Schenectady, N. Y.
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Furnaces, Flue Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Gas
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Lead
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Mechanical Roasting
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Furnaces, Muffle
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Oil
Macleod Co., Bogen St., Cincinnati, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.

Furnaces, Reverberatory
Macleod Co., Bogen St., Cincinnati, Ohio.

Furnaces, Smelting
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Furnaces, Tire Heating
Macleod Co., Bogen St., Cincinnati, Ohio.

Gears
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Generators, Acetylene Welding and Cutting
Macleod Co., Bogen St., Cincinnati, Ohio.

Generators, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Grinders, Sample
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Grizzly & Riffle Bars (For Hydraulic Mines)
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Guns, Cement
Macleod Co., Bogen St., Cincinnati, Ohio.

Guns, Concrete
Macleod Co., Bogen St., Cincinnati, Ohio.

Gyratory Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Hangers, Mine
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Hitchings Mine Car
Macomber & Whyte Rope Co., Kenosha, Wis.

Hoists, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Flory Mfg. Co., S., Bangor, Pa.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoists, Skip
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Hoists, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Hoppers, Weigh
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Hose, Air
Denver Rock Drill Mfg. Co., Denver, Colo.
Goodrich Rubber Co., B. F., Akron, O.

Hydrated Ferric Oxide (For Gas Purification)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Hydraulic Mining Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Insulators, Third Rail
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Jackets, Water
Traylor Engineering & Mfg. Co., Allentown, Pa.

Jaw Crusher Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Jigs
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Laboratory Supplies
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Lamps, Acetylene
Macleod Co., Bogen St., Cincinnati, Ohio.

Lamps, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Crushing Rolls (See Rolls, Crushing)
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Cupro-Magnesium Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Cupro-Vanadium
Primos Chemical Co., Primos, Pa.

Cyanide
Roessler & Hasslacher Chemical Co., 100 William St., New York City.

Cyaniding Equipment
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Dead Burned Magnesite
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Dewaterers
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Diamond Drilling
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

Dredging Machinery
Flory Mfg. Co., S., Bangor, Pa.

Drill Hole Compass (See Compass, Drill Hole)

Drills, Core
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Diamond
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Electric
Denver Rock Drill Mfg. Co., Denver, Colo.
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Drills, Hammer
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Prospecting
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Drills, Rock
Denver Rock Drill Mfg. Co.. Denver. Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Dryers, Ore
Traylor Engineering & Mfg. Co., Allentown, Pa.
Wedge Mechanical Furnace Co., Greenwich Point, Philadelphia, Pa.

Dryers, Rotary
Fuller-Lehigh Co., Fullerton, Pa.

Dryers, Sand and Gravel
Macleod Co., Bogen St., Cincinnati, Ohio.

Dumps, Rotary
Wood Equipment Co., McCormick Bldg., Chicago, Ill.

Dynamite
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Dynamos (See Generators, Electric)

Electrical Machinery
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Elevators, Bucket
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Emery Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

End Loaders (See Loaders, End)

Engines, Gas and Gasoline
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Engines, Haulage
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.

Engines, Hoisting
Flory Mfg. Co., S., Bangor, Pa.
Holmes & Bros., Inc., Robt., 30 N. Hazel St., Danville, Ill.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Engines, Oil
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Engines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Explosives
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Fans, Ventilating
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Feeders, Ore
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Ferro-Chrome
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Molybdenum
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Ferro-Silicon
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Ferro-Tungsten
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Ferro-Vanadium
Primos Chemical Co., Primos, Pa.

Filtering Paper
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Lead Acetate
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Linings, Ball and Tube
Traylor Engineering & Mfg. Co., Allentown, Pa.

Linings, Brake
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Litharge
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Loaders, End
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Loading Booms
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Locomotives, Compressed Air
General Electric Co., Schenectady, N. Y.
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Electric Trolley
General Electric Co., Schenectady, N. Y.
Goodman Mfg. Co., Halstead St. & 48th Place, Chicago, Ill.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Locomotives, Gasoline
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Steam
Vulcan Iron Works, 1744 Main St., Wilkes-Barre, Pa.

Locomotives, Storage Battery
General Electric Co., Schenectady, N. Y.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Low Carbon Ferro-Manganese
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesia Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesite Cement
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnesium Metal (Ingots and Powder.)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Magnetic Pulleys (See Pulleys, Magnetic)

Manganese Dioxide (Lump and Ground)
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Manganese Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Meters, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Mica
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Mills, Ball, Tube and Pebble
Allis-Chalmers Mfg. Co., Milwaukee, Wis
Colorado Iron Works Co., Denver, Colo.
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Mills, Chilean
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Mills, Stamp
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n. 115 Broadway, New York City.

Mine Car Hitchings (See Hitchings, Mine Car).

Molybdate of Ammonia
Primos Chemical Co., Primos, Pa.

Molybdate of Calcium
Primos Chemical Co., Primos, Pa.

Molybdate of Soda
Primos Chemical Co., Primos, Pa.

Molybdenum Metal
Primos Chemical Co., Primos, Pa.

Molybdenum Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Molybdic Acid
Primos Chemical Co., Primos, Pa.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Muffles
Mine and Smelter Supply Co., 42 Broadway, New York City.

Ore-Bedding Systems
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Handling Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Robins Conveying Belt Co., Park Row Bldg., New York City.

Ore Milling Machinery
Colorado Iron Works Co., Denver, Colo.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Ores, Buyers and Sellers of
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Oxy-Acetylene Apparatus
Macleod Co., Bogen St., Cincinnati, Ohio.

Packings, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.
Goodrich Rubber Co., B. F., Akron, O.

Painting Machines
Macleod Co., Bogen St., Cincinnati, Ohio.

Pipe Insulations
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Plate Metal Work
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Platinum Wire, Foil & Ware
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Powder, Blasting
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Powdered Coal Equipment
Fuller-Lehigh Co., Fullerton, Pa.

Power Transmission Machinery
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Presses, Filter
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pulleys, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Pulverizer Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Pulverizers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Pulverizers, Coal and Coke
Fuller-Lehigh Co., Fullerton, Pa.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pulverizers, Ore
Fuller-Lehigh Co., Fullerton, Pa.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Acid
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Hydraulic Pressure
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Pneumatic Air Lift
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Pumps, Power
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Sand
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.

Pumps, Sinking
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Stuff
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pumps, Track
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Pyrometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Quarrying Machinery
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Quicksilver
Beer, Sondheimer & Co., 61 Broadway, New York City.

Refractories
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Respirators
Goodrich Rubber Co., B. F., Akron, O.
Heil Chemical Co., Henry, 210–214 S. 4th St. St. Louis, Mo.

Revolving Screen Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rock Drill Steel (See Steel, Drill)

Rods, Drill
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.

Roller Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Rolls, Crushing
Buchanan Co., C. G., 90 West St., New York City.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Roofings, Asbestos and Rubber-type
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Rope, Wire
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rope Fastenings, Wire
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Rubber Goods, Mechanical
Goodrich Rubber Co., B. F., Akron, O.

Samplers, Ore
Mine and Smelter Supply Co., 42 Broadway, New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Scorifiers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Screens, Bar
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Screens, Perforated Metal
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Screens, Revolving
Buchanan Co., C. G., 90 West St., New York City.
Colorado Iron Works Co., Denver, Colo.
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.
Mine and Smelter Supply Co., 42 Broadway, New York City.
Robins Conveying Belt Co., Park Row Bldg., New York City.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Screens, Shaking
Holmes & Bros., Inc., Robt., 30 N. Hasel St., Danville, Ill.

Separators, Magnetic
Buchanan Co., C. G., 90 West St., New York City.

Shaft Sinking and Development Work
Longyear Co., E. J., 710 Security Bldg., Minneapolis, Minn.

CLASSIFIED LIST OF MINING AND METALLURGICAL EQUIPMENT

Sharpeners, Drill
Denver Rock Drill Mfg. Co., Denver, Colo.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Silica Brick
Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa.

Skip Hoists (See Hoists, Skip)
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Smelters
Beer, Sondheimer & Co., 61 Broadway, New York City.
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Smelting Machinery
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Colorado Iron Works Co., Denver, Colo.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Worthington Pump & Machinery Corp'n., 115 Broadway, New York City.

Soda Ash
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Spelter
Illinois Zinc Co., Peru, Ill.

Spiegeleisen
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Sprockets
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Stamp Mill Parts
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Steel, Crucible
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.

Steel, Drill, Hollow and Solid
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
Denver Rock Drill Mfg. Co., Denver, Colo.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.
Sullivan Machinery Co., 122 So. Michigan Ave., Chicago, Ill.

Steel, Tool
Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa.
International High Speed Steel Co., 99 Nassau St., New York, N. Y.

Stokers
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Tables, Concentrating (See **Concentrators**)

Test Lead
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thawers, Switch
Macleod Co., Bogen St., Cincinnati, Ohio.

Thermometers
Heil Chemical Co., Henry, 210–214 S. 4th St., St. Louis, Mo.

Thickeners, Slime
Colorado Iron Works Co., Denver, Colo.
Dorr Co., Denver, Colo.

Tipple Machinery Equipment
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Torches, Cutting and Welding
Macleod Co., Bogen St., Cincinnati, Ohio.

Towers and Bridges, Stocking and Reclaiming
Robins Conveying Belt Co., Park Row Bldg., New York City.

Tramways, Wire Rope, Aerial
Leschen & Sons Rope Co., A., 920 N. 1st St., St. Louis, Mo.
Macomber & Whyte Rope Co., Kenosha, Wis.
Roebling's Sons Co., John A., Trenton, N. J.

Transformers, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Traps, Steam
Johns-Manville Co., H. W., 296 Madison Ave., New York City.

Tungstate of Ammonia
Primos Chemical Co., Primos, Pa.

Tungstate of Soda
Primos Chemical Co., Primos, Pa.

Tungsten Metal
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Tungsten Ore
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.

Tungsten Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Tungstic Acid
Lavino and Co., E. J., Bullitt Bldg., Philadelphia, Pa.
Primos Chemical Co., Primos, Pa.

Turbines, Hydraulic
Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Valves, Pump
Goodrich Rubber Co., B. F., Akron, O.

Vanadate of Ammonia
Primos Chemical Co., Primos, Pa.

Vanadic Acid
Primos Chemical Co., Primos, Pa.

Vanadium Chloride
Primos Chemical Co., Primos, Pa.

Vanadium Ore, Buyers of
Primos Chemical Co., Primos, Pa.

Ventilating Fans (See Fans, Ventilating)

Wagon Loaders
Jeffrey Mfg. Co., 902 N. 4th St., Columbus, Ohio.

Weigh Hoppers (See **Hoppers, Weigh**)

Wheels
American Manganese Steel Co., McCormick Bldg., Chicago, Ill.

Wheels, Mine Car
Fuller-Lehigh Co., Fullerton, Pa.

Wire, Iron, Steel and Copper
Roebling's Sons Co., John A., Trenton, N. J.

Wire Mechanism (Lever Control)
Gwilliam Co., 253 W. 58th St., New York City.

Wire Rope (See **Rope, Wire**)

Wires and Cables, Electrical
General Electric Co., Schenectady, N. Y.
Goodrich Rubber Co., B. F., Akron, O.
Roebling's Sons Co., John A., Trenton, N. J.

Zinc Dust
Vogelstein & Co., Inc., L., 42 Broadway, New York City.

Zinc Sheet
Illinois Zinc Co., Peru, Ill.

ALPHABETICAL LIST OF ADVERTISERS

(With Summary of Products)

See pages 30–39 for Classified List of Mining and Metallurgical Equipment

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

 [Please mention this BULLETIN when writing advertisers.]

ALPHABETICAL LIST OF ADVERTISERS (Continued)

* Advertisement does not appear in this issue, but products are listed in Classified List of Mining and Metallurgical Equipment.

PRINCIPAL OFFICE, SCHENECTADY, N. Y.
SALES OFFICES IN ALL LARGE CITIES